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(Materials & Methods Manual No. 77)

BORON STEELS
LEAN ALLOYS
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The Materials Outlook

Government and Controls Picture: Scrap is just as tight in copper and aluminum as it is in steel. As more aluminum capacity comes in, scrap will get even worse . . . . Steel supply is shortest in bars and shapes. Rolling capacity is lacking . . . . NPA is striving for the irreducible minimum use of nickel alloys. This would include dairy equipment, for instance. Stainless is required by law here . . . . Fleischmann says we are just going into the toughest period for shortages. Military demand will level off by next summer, and then go down.

The demand for domestic primary pig lead is more than three times the supply. Manufacturers lead inventories have decreased steadily since January . . . . World production of lead is about the same this year as in 1950, but demand is up. U. S. imports are down because our price (17¢ a lb) is way below British and European figure (23½¢) . . . . No improvement in sight.

Despite record U. S. copper production in 1950 and '51, there is an acute copper shortage, which will increase in intensity in 1952 . . . . Manufacturers' inventories are almost non-existant and U. S. price is low, cutting down imports . . . . There is no improvement in sight, even in the long run. Better start thinking about substituting aluminum for copper wherever possible in the years ahead.

Defense demand has put aluminum under controls, but the long range outlook is good . . . . The 1950 output was a peacetime record. By 1952, our aluminum capacity will easily top peak World War II production . . . . As the defense effort subsides, aluminum will become available for all present needs and a lot of new applications.

A high-temperature alloy for jet service at 1500 F has been developed. It has a high percentage of iron, and no cobalt . . . . The composition: 26 nickel, 15 chromium, 1.25 molybdenum, 2 titanium, 0.08% (max) carbon, fractional percentages of aluminum and vanadium, and the balance iron.

A new one-coat porcelain enamel process does not require special enameling steel. A non-chipping, non-cracking coat is produced. Previous one-coat enamels needed premium price sheet . . . . The new coat is about 0.004 in. thick, half the thickness of two-coat enamel. It is flexible and can be sheared, sawed, drilled or punched without chipping . . . . No scarce cobalt is needed, without the ground coat.

(Continued on page 4)

The Materials Outlook *(continued)*

Porcelain enamelers are looking around for new applications. Less than 1% of the industry's production is going for defense, while civilian business—in household appliances, especially—is slackening off. Not more than 75% of the industry's capacity is being used . . . . Big enamel defense applications so far are jet engine parts, submarine mufflers, and other items that need high protection against corrosion and heat.

A bright tin-nickel plate has been introduced in England. The alloy coating is two parts tin and one part nickel. Color is faint rose. The coating has remarkable corrosion and tarnish resistance, and the process is not difficult to control. It is being touted as a serious rival to chromium plating.

Volatile crystals function as a rust preventative in packaged or confined areas. Metal can be removed at any time, with no film to clean off . . . . Volatile crystals are also being studied as a means of improving the compressibility of metal powders to reduce ram pressures.

Rolling capacity for magesium will be increased early in 1952 by a mill to roll magnesiumm sheet from slabs. Brooks & Perkins, magnesium fabricators, will operate the mill . . . . B & P figures this will eliminate supply delays on sheet and cut scrap losses. The limited stock sizes available now often involve 50% waste in cutting required blanks.

A series of tests are now being run on tungsten carbide bearings to determine their practicability in high-speed machines. Test bearings have been finished to dimensional accuracy of one millionth of an inch and a surface finish of 1 to 3 micro-inches. Tests have been run at different speeds, conditions of loading and lubrication for over a year and a considerable amount of data have been accumulated. One bearing has run 200 hr at 450 psi with no size change measurable to 1/100,000 in. Other tungsten carbide bearings have run at 2000 psi, and higher pressures are on the program.

The amount of radioactive cobalt shipped to industry in the past 12 months was 564% greater than the total amount supplied in the first four years of the program. Some 72 companies are now using radiocobalt for radiography inspection of castings and weldments. Among the new applications are: (1) a method for determining the concentration of sulfur in chromium plating baths; (2) a technique for measuring the self-diffusion of cobalt in metals; and (3) a test for forecasting the extent of the deterioration of an asphalt road due to water action. Several companies have applied for privately-owned production facilities for radioisotopes.

The development of a new gear-manufacturing process employing carburization, which limits distortion to 0.001 in. per ft of dia, has been announced. The accuracy of the heat regulation accounts for the fine tolerances. Some 20-in. gears now in production distort less than 0.0015 in., while distortion of identical gears by older methods varies from 0.015 to 0.045 in.

See page 7 for "Materials Control Orders"

Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from Sept. 11, 1951 through Oct. 10, 1951.

● CONTROLLED MATERIALS PLAN

Reg. 3, Amended—Establishes new DX symbol for emergency use in ordinary products or materials other than steel, copper or aluminum. The symbol is to receive priority over all other symbols except as provided in NPA Regulation 2 (see below). Use of symbol is restricted to components and cannot be applied to heavy power equipment, complete machine tools, and controlled raw materials.

Dir. 3 to Reg. 1—Manufacturers may now order up to 40% of their quarterly allotments of controlled materials for delivery in any one month of the quarter, an increase of 5%.

Dir. 4 to Reg. 1—Steel producers may buy steel, without deducting the tonnage from their allotments, from an importer who takes title to it before it arrives in the United States. Such producers may manufacture more products than the quantity shown on their authorized production schedules.

Dir. 7 to Reg. 1; Dir. 3 to Reg. 6; Reg. 1, Amended—Any unfilled order for third-quarter delivery of steel, copper or aluminum not shipped by Oct. 7 must be charged by a customer to his fourth-quarter allotment.

● ALUMINUM (Orders M-5, M-47B, M-84)

Aluminum must be of the lowest grade necessary when used for purposes from which it cannot be recovered ("destructive" purposes). CMP allotment symbols are set up to permit "destructive" users to obtain their supplies by self allotment. Producers of ferro alloys limited to their average use during January 1950. Use in steel deoxidizing limited to an average of 0.6 lb of Grade 4 deoxidizing ingot per month for every ton of carbon steel, 2 lb for each ton of alloy steel, and 2.5 lb for each ton of steel castings. Manufacturers of specified consumer hard goods may shift production from one product to another in the same group (see Iron and Steel, below). NPA must approve use of aluminum in products not produced since June 30, 1949 or for which no allotment was made. Use of aluminum prohibited: (1) for any ornamental purpose on any listed product; (2) in greater quantity than necessary for functional or operational purposes. Producers must cancel any order scheduled for delivery on, or after, Oct. 1 except those valid in fourth quarter.

● ARTIFICIAL GRAPHITE (Order M-66)

Delivery of artificial graphite and carbon electrodes prohibited unless under authorized allocation by NPA. Graphite electrodes less than ¾ in. in cross-section excluded. Consumer inventory reports must now be made quarterly rather than monthly.

● COPPER (Orders M-12, M-47B, M-86)

M-12 is rescinded as its provisions are now included in orders M-47B, M-4, M-74, M-16 and CMP Regs. 5 and 6. Manufacturers of specified products may shift production from one product to another in the same group. NPA must approve use of copper in products not produced since June 30, 1949 or for which no allotment was made. Use of copper prohibited: (1) for any ornamental purpose on any listed product; (2) in greater quantity than necessary for functional or operational purposes. As of Nov. 1, distributors of wire mill products are permitted to replenish stocks sold out of inventory to meet (ACM) authorized controlled materials orders. Wire mill products are defined to include bare wire and cable and insulated wire and cable made from copper, copper-base alloy and copper-clad steel with more than 20% copper by weight. Distributors may also replace part of their inventories to meet anticipated ACM orders if their inventories are abnormally low. A special X6 symbol is established to be placed on orders to meet these purposes. Stock replenishment is limited to 25% of all the wire products shipped during the base period (year 1950) or the last fiscal year prior to that, whichever is selected by the distributor. From this must be deducted the copper poundage of all products on hand Sept. 30, 1951. If fourth-quarter orders exceed the amount permitted under the order, distributors must cancel the difference.

● IRON AND STEEL (Order M-47B)

Manufacturers of civilian hard goods products may shift production from one product to another listed in the same group. The order defines four groups of hard goods products as follows: (1) furniture, fixtures and canvas products; (2) appliances, machines and electrical equipment; (3) housewares and personal durable goods; (4) other goods, including home furnishings, jewelry, musical goods, sporting goods, toys, bicycles and motorcycles.

● MOLYBDENUM (Order M-81)

Anticipated Changes: Pieces of molybdenum wire and rod cut to specific lengths may be placed under allocation. Requirements of the electronics industry will increase substantially during the first half of 1952 in the production of power tubes.

● NICKEL SILVER (Order M-80)

Amendment to Schedule A permits the use of nickel silver in the manufacture of musical instruments, including flute and piccolo bodies, woodwind instruments, pistons in all valve instruments, and trombone inside slides.

● PLASTIC-TYPE NYLON (Order M-45)

Material is now allocated, under Appendix B, by the calendar month. Controls are eased to eliminate: requirement that purchasers seek NPA authorizations to buy; time limitation on any NPA authorizations to use it. Producers must have NPA authorizations to sell the material while purchasers must certify their planned uses to their suppliers. Shipments of level monofilament up to 25 lb a month and of molding granules up to 540 lb a month are exempted.

● TIN (Order M-8)

Restrictions on pig tin are extended into calendar quarters succeeding the third quarter of 1951. No person may use, in any quarter, in any product, in excess of 90% of the average quarterly use of pig tin during the base period except as stated in the order. Use during any one month may not exceed 40% of the quarterly allotment.

● TUNGSTEN (Order M-81)

Anticipated Changes: Pieces of tungsten wire and rod cut to specific lengths may be placed under allocation. Present supplies just ballance consumption but increased requirements of electronics industry in first half of 1952 may bring tighter controls.

● ZINC

Anticipated Changes: It appears the NPA will maintain its present system of allocating slab zinc, having ruled out suggested changes made by zinc users up to now.

● NPA REGULATIONS

Reg. 2—Establishes emergency DX symbol but provides that rated orders bearing program identifications A, B, C or E which have been accepted and scheduled for delivery must be given first preference if supplier is unable to make deliveries on time.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

For several years this space has been used to tell how Revere has collaborated with its customers, to mutual benefit. Now we want to talk about the way our customers can help us, again to mutual benefit. The subject is scrap. This is so important that a goodly number of Revere men, salesmen and others, have been assigned to urge customers to ship back to our mills the scrap generated from our mill products, such as sheet and strip, rod and bar, tube, plate, and so on. Probably few people realize it, but the copper and brass industry obtains about 30% of its metal requirements from scrap. In these days when copper is in such short supply, the importance of adequate supplies of scrap is greater than ever. We need scrap, our industry needs scrap, our country needs it promptly.

Scrap comes from many different sources, and in varying amounts. A company making screw-machine products may find that the finished parts weigh only about 50% as much as the original bar or rod. The turnings are valuable, and should be sold back to the mill. Firms who stamp parts out of strip have been materially helped in many cases by the Revere Technical Advisory Service, which delights in working out specifications as to dimensions in order to minimize the weight of trimmings; nevertheless, such manufacturing operations inevitably produce scrap. Revere needs it. Only by obtaining scrap can Revere, along with the other companies in the copper and brass business, do the utmost possible in filling orders. You see, scrap helps us help you.

In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

So Revere, in your own interest, urges you to give some extra thought to the matter of scrap. The more you can help us in this respect, the more we can help you. When a Revere salesman calls and inquires about scrap, may we ask you to give him your cooperation? In fact, we would like to say that it would be in your own interest to give special thought at this time to all kinds of scrap. No matter what materials you buy, the chances are that some portions of them, whether trimmings or rejects, do not find their way into your finished products. Let's all see that everything that can be re-used or re-processed is turned back quickly into the appropriate channels and thus returned to our national sources of supply, for the protection of us all.

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Steel Bar Stock Cold Extruded Without Special Surface Lubrication

Commercial steel products can now be cold extruded without using tremendous presses and high pressures, according to the Mullins Manufacturing Co. The new process, called "Koldflo", requires no special surface lubrication. Koldflo is being licensed by Mullins to steel fabricators.

The Koldflo Process, according to Mullins' announcement, is cold extrusion plus—plus the ability to extrude commercially on available presses and in combination with other press operations, such as drawing, ironing, coining and forging. The pressures required to make a steel bar flow in the cold state are surprisingly low. In announcing the process, Mullins engineers revealed that one of their discoveries is that they can control the flow of steel under pressure so as to direct it where they want it to go with a minimum of internal and external friction. The ability to do this, they say, disproves the popular concept that tremendous pressures and huge presses are required to do such work. Actually, abundant press equipment exists which can be used to cold extrude steel by the Koldflo Process.

Mullins first announced its work in the cold extrusion field when it revealed last year that it had developed a successful method for cold extruding 105-mm shells for the Ordnance Department, who recognized the need for such a process. Mullins made substantial contributions to the development of shell manufacturing in the course of fulfilling orders received from the Ordnance Department. As a result of these developments, the Company received contracts to build the first plant in the country for the mass production of shells by this method. The plant will go into operation in Warren, Ohio shortly to fulfill more than $20,000,000 worth of Army and Navy contracts.

The Koldflo process for cold extrusion of steel, originally designed to make 105-mm shells, has also been developed for commercial use to make thin-walled cylinders, pulley hubs, axle parts, and even gears by forcing the steel to flow cold under pressure.

The Koldflo Process goes far beyond the cold extrusion process used for making shells, which deals with heavy-walled, cylindrical shapes. Now the process can be applied to shapes represented by such objects as thin-walled pressure cylinders, shock absorber cylinders, gear blanks, pulley hubs, bearing housings, and hub and axle components for vehicles.

The process will result in substantial cost savings on those parts which can be made by it, as well as produce a superior product, developing engineers say. For example, scrap is virtually eliminated, as only enough metal to make the part is cut from a solid bar. Stamping, forging or machining cylindrical objects from flat blanks or from rounds of necessity wastes from one-fourth to one-third of the original steel. In the making of artillery shells, Army Ordnance has estimated that if all the 105-mm shells of World War II had been made by the cold extrusion process, a million tons of steel would not have been reduced to scrap.

The process is so exact that weight and size tolerances can be held within

(Continued on page 10)

BEFORE—*Stacking sheet metal flat took too much space at Pratt & Whitney Aircraft, East Hartford, Conn. Handling 355 different sizes, thicknesses and compositions of metal was inefficient and costly, and the scrap-rate from handling damage was excessive.*

AFTER—*Sheets are now stored vertically, each kind in a separate plywood-covered, steel-framed book. The books are card-indexed and move to the presses and shears on a monorail. Handling labor was cut 90% and storage space 50%.*

the limits required for most mass-produced precision parts. Parts are produced with glass-smooth surfaces. This means that many products would not require any expensive finish-machining.

Mullins engineers state that other important economies would come from the elimination of man-hours and the savings in machinery and plant space over other methods of forming metal. Another advantage of the process is that it creates a stronger steel through cold working the metal. With some products this could mean the elimination of heat treating operations, and it could mean the use of steel containing less alloy, such as manganese, chromium and nickel. Company engineers also point to the versatility of the process, which they say will coin, extrude forward and backward, compress, expand and iron.

Mullins has granted several licenses under which one company already is tooling to produce a pressure cylinder. Additional licenses are being negotiated.

Interest in cold extrusion of steel received considerable impetus after World War II when it was discovered that the Germans were using such a process in a limited way. A drawback to the German technique was that it required extremely large presses, some of them exerting pressures up to 30,000 tons, and it used an elaborate method of lubricating the metal before it was extruded. The new process is not the same as the German process, by virtue of its adaptability to standard presses and normal lubricating procedure.

Symposium Discusses Materials Problems in Nuclear Engineering

Oak Ridge, Tenn. — Industry is benefitting in almost all fields of engineering in countless ways from the tremendous contributions engineering is making to nuclear energy development.

All technological and economic angles of that theme were discussed for more than 500 engineers and scientists who attended the third annual Oak Ridge Summer Symposium at the Atomic Energy Commission's Oak Ridge, Tenn. site. First of the nuclear energy symposia devoted to engineering, the two-week long discussion of "The Role of Engineering in Nuclear Energy Development" was conducted by the Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies, under the sponsorship of the American Society for Engineering Education.

More than 6600 engineers—half of all the scientific and technical personel in the atomic energy program today—are striving to supply "engineering beyond handbook limits" for a great variety of technological requirements in the program, AEC Commissioner T. Keith Glennan told the Symposium audience. In remarks opening the conference, Dr. Glennan stressed the vital importance of these engineering developments and called attention to current efforts of the Commission and cooperating organizations to provide "the broad spectrum of engineering education needed to qualify personnel for work in the atomic energy program."

Dr. George E. Evans, of the ORNL Training Div., summarized materials development in the atomic energy programs in these principal projects — studies of commercially available materials of potential or known reactor usefulness, new metals and alloys which appear promising, liquid metal coolants and cooling systems, refractory metals, ceramics and metal-ceramics for high temperature use, as well as a survey of the effects of reactor radiation on all proposed materials.

"A better understanding of how a great many materials will behave in meeting such new conditions is coming from the test program on reactor materials, and broad applications of these will come in general engineering," Dr. Evans predicted.

Heat transfer engineers are devoting attention to liquid metals and fused salts, but have a lot to learn about their physical properties before solving heat transfer problems in nuclear reactors, according to Dr. Richard N. Lyon, of the ORNL Reactor Experimental Engineering Div. He described special problems in forced convection heat transfer, especially in tubes of non-circular cross-section, and in ordinary to sub-cooled boiling.

Complete transactions of the Symposium will be published by the AEC technical information services. This document (TID-5031) will be available for a nominal charge after Dec. 1 from the Office of Technical Services, Dept. of Commerce, Washington 25, D. C.

ASME Meeting Discusses Materials Problems

Three papers of interest to materials engineers were contributed by the Metals Engineering Div. of the American Society of Mechanical Engineers for presentation at the fall meeting of the Society in Minneapolis.

Harry Majors, Jr., director, Engineering Experiment Station, University of Alabama, discussed the dynamic properties of nodular cast iron in one paper. This paper presents the experimental results of an investigation on the mechanical properties of magnesium-treated nodular cast iron in the annealed and as-cast condition. The dynamic stress-concentration factors are compared with Neuber's theoretical factors for hyperbolic notches, with Peterson's results on steel, with Frocht's photoelastic results, and with Grant's data on flake cast iron and cerium-treated nodular iron. Fatigue results are shown for square and 45-deg V-shaped notches at speeds of 200 and 6000 rpm, as well as for various notch depths. The trend in size effect is indicated. Static damping capacities obtained from hysteresis loops in tension and compression are compared with torsional damping capacities and static damping capacities from bending.

Another paper, by M. C. Steele, research assistant professor, and John Young, research assistant, Dept. of Theoretical and Applied Mechanics, University of Illinois, covers an experimental investigation of overstraining in mild steel, thick-walled cylinders by internal fluid pressure. The purpose of this paper is to study the mechanism of yielding and to compare with plastic theories strains observed at the bore and outside surface of mild-steel cylinders of 2:1 diameter ratio under internal fluid pressure. Observations disagree with theoretical assumptions concerning the progression of yielding; wedge regions of overstrained material, occupying a small fraction of the total volume, characterize the yielding process. Discrepancies with theory are observed in the measured strains. The fully plastic load-carrying capacities predicted from theory are higher than those observed in the experiments. Stability of deformation (creep) under maintained constant loads is discussed.

A roundup on the forging of munition shells was given in the third paper by W. Trinks, partner, Associated Engineers, Pittsburgh. This paper describes the forging methods, with particular attention to the upsetting processes, adapting the bulldozer, the pierce and draw process, the cross rolling, the nosing operation, and the operations preceding forging. This discussion covers hot forging. Another short section of the paper briefly describes the cold forging or cold extrusion process used by the Mullins Manufacturing Co. in shell manufacture.

New Industrial Forms of Teflon Announced

Du Pont chemists have made public for the first time detailed and fundamental information about their dispersions of Teflon tetrafluoroethylene resin in water, a new form of their heat resistant plastic, and revealed ways in which the plastic can be used industrially other than by molding and extrusion, to which the polymer has hitherto been limited.

The disclosures were in two papers delivered before the Symposium on Fluorine-Containing Polymers of the Diamond Jubilee Meeting of the American Chemical Society. First of the two papers was presented by J. F. Lontz, and the second by J. A. Jaffe, both of whom are research chemists in du Pont's Polychemicals Dept. Laboratory at the Experimental Station in Wilmington, Del. Coauthors are W. B. Happoldt, Jr., likewise of the Polychemicals Dept. Laboratory, and L. E. Robb, formerly a du Pont chemical engineer and now with the Rockbestos Products Corp.

Dr. Lontz and Mr. Jaffe brought up-to-date public information about aqueous collodial dispersions of Teflon, announced in Nov. 1949, after years of research aimed at developing a new type of product in fluid form, suitable for various industrial applications. The electrical and chemical industries, in particular, have many requirements for a plastic of the type

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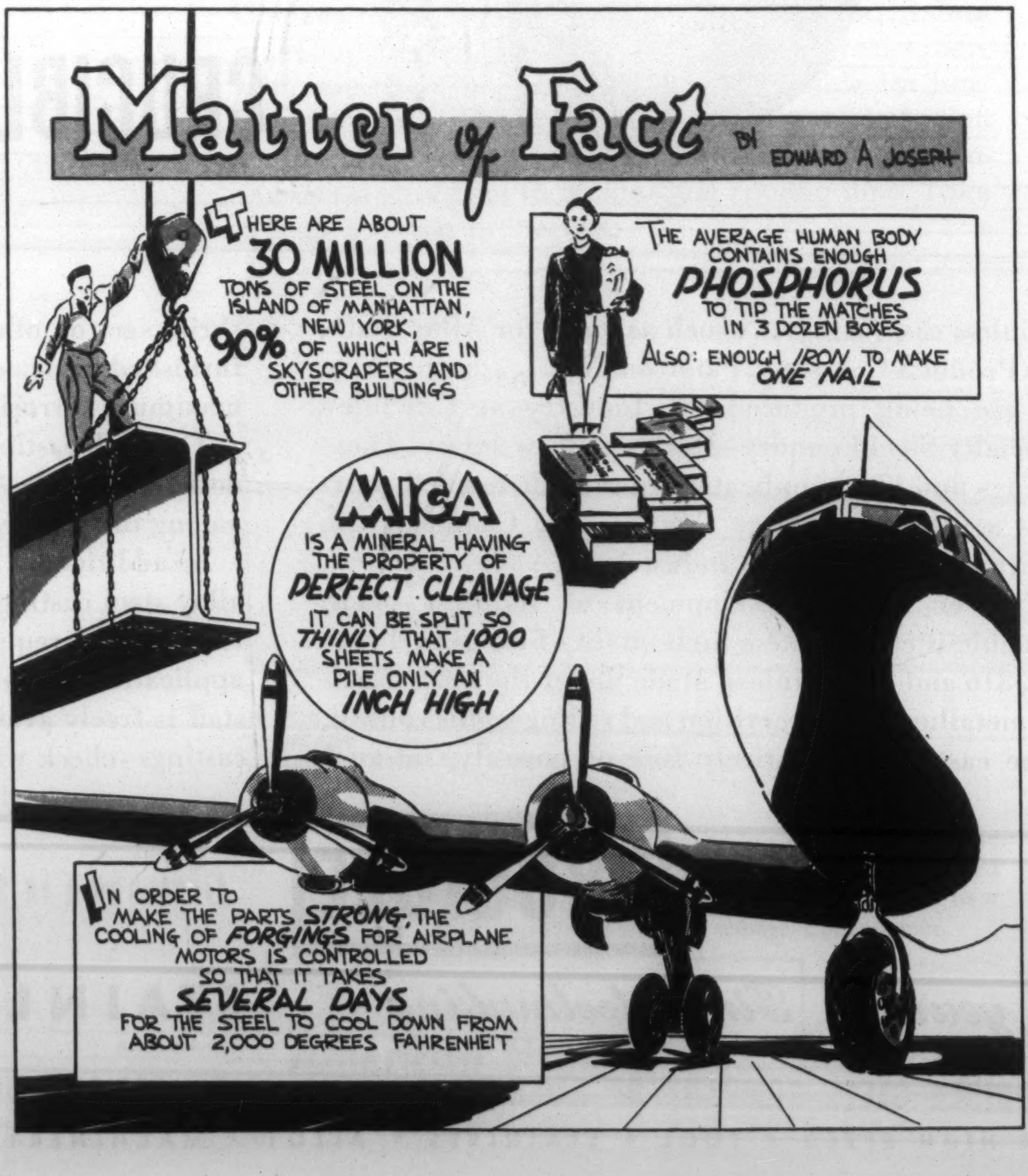
Matter of Fact
BY EDWARD A JOSEPH
THERE ARE ABOUT 30 MILLION TONS OF STEEL ON THE ISLAND OF MANHATTAN, NEW YORK, 90% OF WHICH ARE IN SKYSCRAPERS AND OTHER BUILDINGS
THE AVERAGE HUMAN BODY CONTAINS ENOUGH PHOSPHORUS TO TIP THE MATCHES IN 3 DOZEN BOXES
ALSO: ENOUGH IRON TO MAKE ONE NAIL
MICA IS A MINERAL HAVING THE PROPERTY OF PERFECT CLEAVAGE
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Pioneer in the development of stainless steels, Crucible is casting these high quality fittings in Types 304, 316 and 347 stainless. Made under the most exacting metallurgical supervision and radiographic control, these castings are entirely free of porosity, internal shrinkage, or other casting defects. The castings are furnished annealed, blast cleaned and passivated for maximum corrosion resistance.

The high casting quality plus the particularly husky design make the Alloy Stainless Products' pipe fittings among the leaders in the field.

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CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

News Digest

continued from page 11

of Teflon because of its high resistance to heat and chemicals, its excellent insulating properties, particularly at high frequency, and its anti-adhesiveness.

The du Pont chemists reported in detail on methods for casting unsupported film, and pointed out the application of Teflon dispersions in coating glass cloth. Films cast from Teflon dispersions, which can be made as thin as one-quarter of one-thousandth of an inch, are expected to find application for various insulation purposes where mica is now used, particularly in the development of new and more compact radar equipment. Glass fabrics coated or impregnated with Teflon tetrafluoroethylene resin also should find numerous uses in the insulation field. They are already finding important applications in aircraft electrical systems.

By making available detailed data on the properties of Teflon dispersions, and spelling out various steps in the filmcasting and extraction processes, the chemists hoped to interest other researchers in investigating the potentialities of the new forms of the plastic.

Laboratory Research on Notch Sensitivity and Copper Conductivity Reported

The national Advisory Committee for Aeronautics recently issued several interesting reports summarizing research projects carried on by government and private laboratories on engineering materials. Bound copies of these Technical Notes are available from the NACA, Washington, D. C.

Technical Note 2459 summarizes work done on a theory of conductivity of cold-worked copper by Rolf Landaver at the Lewis Flight Propulsion Laboratory. The increase in the resistivity of copper under cold working is calculated. The increase is assumed to be caused by dislocations surrounded by a long-range electrostatic field that scattered the conduction electrons. The amount of scattering is found by the method of

(Continued on page 146)

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Compression Strength, Psi.	4000
Transverse Strength—Modulus of Rupture, Psi.	2000-6000
Hardness at 77°F. Shore "D"	70-75
Coeff. of Expansion inch/Deg. C.	0.00005
Heat Distortion Temp. Deg. F.	135-180
Dielectric Strength, 60 cycles, v/mil	Over 200
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Materials & Methods
NOVEMBER 1951

Zinc

—Its Sources, Uses and Supply

by **CHARLES A. SCARLOTT,** Westinghouse Electric Corp.

Zinc is one of our indispensable metals whose consumption curve is steeply rising as old uses are growing and new ones are continually added.

● ZINC IS NOT a spectacular metal. It does not have the popular appeal, either inherent or by virtue of glamorous applications, of other metals, such as copper, aluminum and magnesium. Neither does it make the headlines as an international political issue, as does tin. Zinc is, instead, a workhorse metal and one of the most indispensable. How much so is indicated by the fact that it stands fourth among metals in amount used by the world each year. In tonnage it is surpassed only by iron, copper and lead.

Zinc, once called spelter, has had a long history. Museums display brass objects known to have been made before 500 B.C., although zinc was probably not then known as a separate metal. The modern zinc industry began with the development of smelting in Belgium in 1806, and the United States got into the act in a serious way in 1858, using New Jersey ores. The United States has been the world's leading zinc producer since 1909.

Zinc Sources and Production

Nature was both generous and quite impartial when she laid down the earth's concentrations of zinc ore. Last year 17 nations, some in every continent, each mined more than 10,000 short tons of zinc yearly. The total world production mounted to about two million tons. This does not include Soviet Union and her satellites. Russia is believed to be producing about 120,000 tons of zinc yearly and Poland about 90,000.

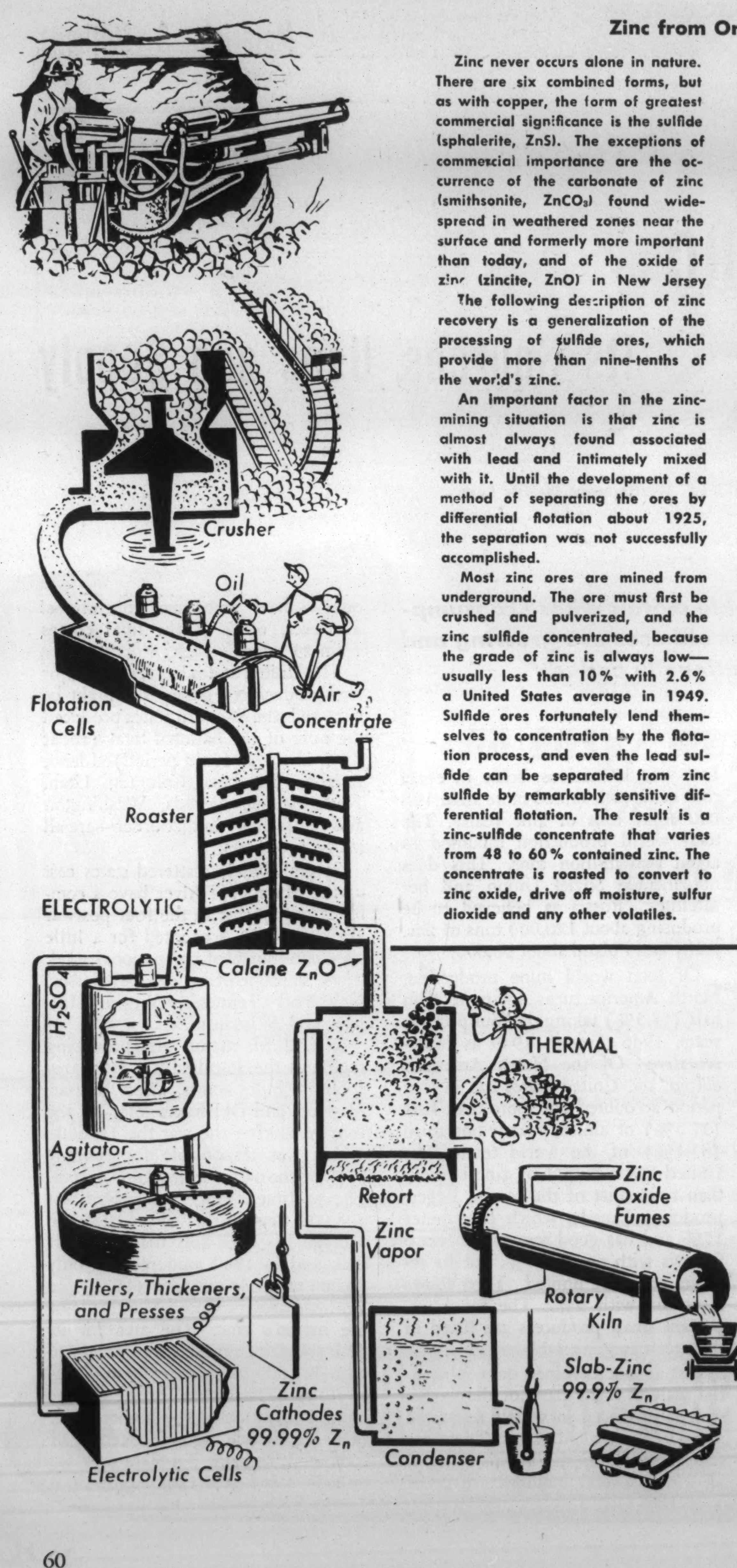
Of total world mine production, North America turns out more than half (57.5%) taking the four postwar years, 1946 through 1949 as representative. Of the North American output, the United States has in that period accounted for more than half (57.5%) or almost exactly one third (33.1%) of the world total. The United States output of zinc is more than twice that of the second largest producer, Canada, which contributes 15% and has good reserves. Mexico follows with nearly 10%, but its reserves are more limited. Then comes Australia with 9%. The more important small producers are listed in the accompanying table.

Just as zinc is mined on a substantial scale in many parts of the world, so it is produced in widely separated areas in the United States. There are some 750 zinc mines in this country, of which several hundred are small ones — even one-man operations. However, 60% of the total comes from 25 mines.

The United States has several major zinc-producing regions. As might be expected, the Western states produced the bulk of the national total (about 55% in the 1946-49 period). Idaho, Arizona, Montana, Colorado, Utah, New Mexico, Nevada, Washington and California—in that order—are all major producers.

Several widely scattered states east of the Mississippi River have a combined output that in the four postwar years, 1946-49, accounted for a little over one-fourth of the national total. These states, in order, are New Jersey, New York, Tennessee, Virginia, Illinois and Wisconsin.

The third major zinc-producing region is the so-called Tri-State area about 30 miles across, where Kansas, Missouri and Oklahoma join. In the four years after the war the Tri-State region was responsible for roughly 17% of the nation's zinc-mine output. The wartime average production was 225,000 tons yearly. Since 1945 the average has been less than one-half that, and in 1949 amounted to only 80,000 tons. At one time (1921) the Tri-State area produced two-thirds of the nation's zinc. The area hit its peak of zinc production in 1926 with 424,000 tons (and 100,000 tons of lead). The reason for the decline is the exhaustion of the higher grade ores. A decade ago the tenor of combined lead-zinc Tri-State ores (as mined) stood at 6.12%. Now it is



Zinc from Ore to Slab

Zinc never occurs alone in nature. There are six combined forms, but as with copper, the form of greatest commercial significance is the sulfide (sphalerite, ZnS). The exceptions of commercial importance are the occurrence of the carbonate of zinc (smithsonite, $ZnCO_3$) found widespread in weathered zones near the surface and formerly more important than today, and of the oxide of zinc (zincite, ZnO) in New Jersey

The following description of zinc recovery is a generalization of the processing of sulfide ores, which provide more than nine-tenths of the world's zinc.

An important factor in the zinc-mining situation is that zinc is almost always found associated with lead and intimately mixed with it. Until the development of a method of separating the ores by differential flotation about 1925, the separation was not successfully accomplished.

Most zinc ores are mined from underground. The ore must first be crushed and pulverized, and the zinc sulfide concentrated, because the grade of zinc is always low—usually less than 10% with 2.6% a United States average in 1949. Sulfide ores fortunately lend themselves to concentration by the flotation process, and even the lead sulfide can be separated from zinc sulfide by remarkably sensitive differential flotation. The result is a zinc-sulfide concentrate that varies from 48 to 60% contained zinc. The concentrate is roasted to convert to zinc oxide, drive off moisture, sulfur dioxide and any other volatiles.

The resulting calcine, ZnO, now can proceed to slab zinc by either of two routes—one thermal, the other electrolytic.

In the thermal process the oxygen molecule is persuaded, by heat, to give up zinc for carbon. This is done either in the batch type horizontal retort or the newer, and more efficient, continuous vertical retort. In either case the zinc calcine and coal (or coke) is charged separately or combined as briquettes into the furnace and heated. Heat is provided either by an excess of coal or by passage of electricity through the mass.

The zinc, now freed from the oxygen, emerges as a gas and passes to a condenser. In one type of condenser the zinc vapor is bubbled through a bath of molten zinc which condenses it and the surplus drawn off at intervals and cast into slabs for market. Meanwhile, residue from the retort is routed through a rotary kiln where a large portion of the zinc that escaped gasification in the retort is separated as a fume and trapped as a dust.

If the zinc is to be won electrolytically, the calcine from the roaster is stirred with sulfuric acid, and the resulting zinc sulfate, water and residue is passed through filters and thickeners. It is further purified by the addition of zinc dust and filtered again to provide a clear neutral solution of zinc sulfate. This solution is dripped as feed into the electrolytic cells. Zinc is deposited on aluminum cathodes and subsequently stripped off, melted and poured into slabs.

3.4%. However, there is probably nearly a million tons of zinc (and 165,000 tons of lead) left. How much will be recovered is a question.

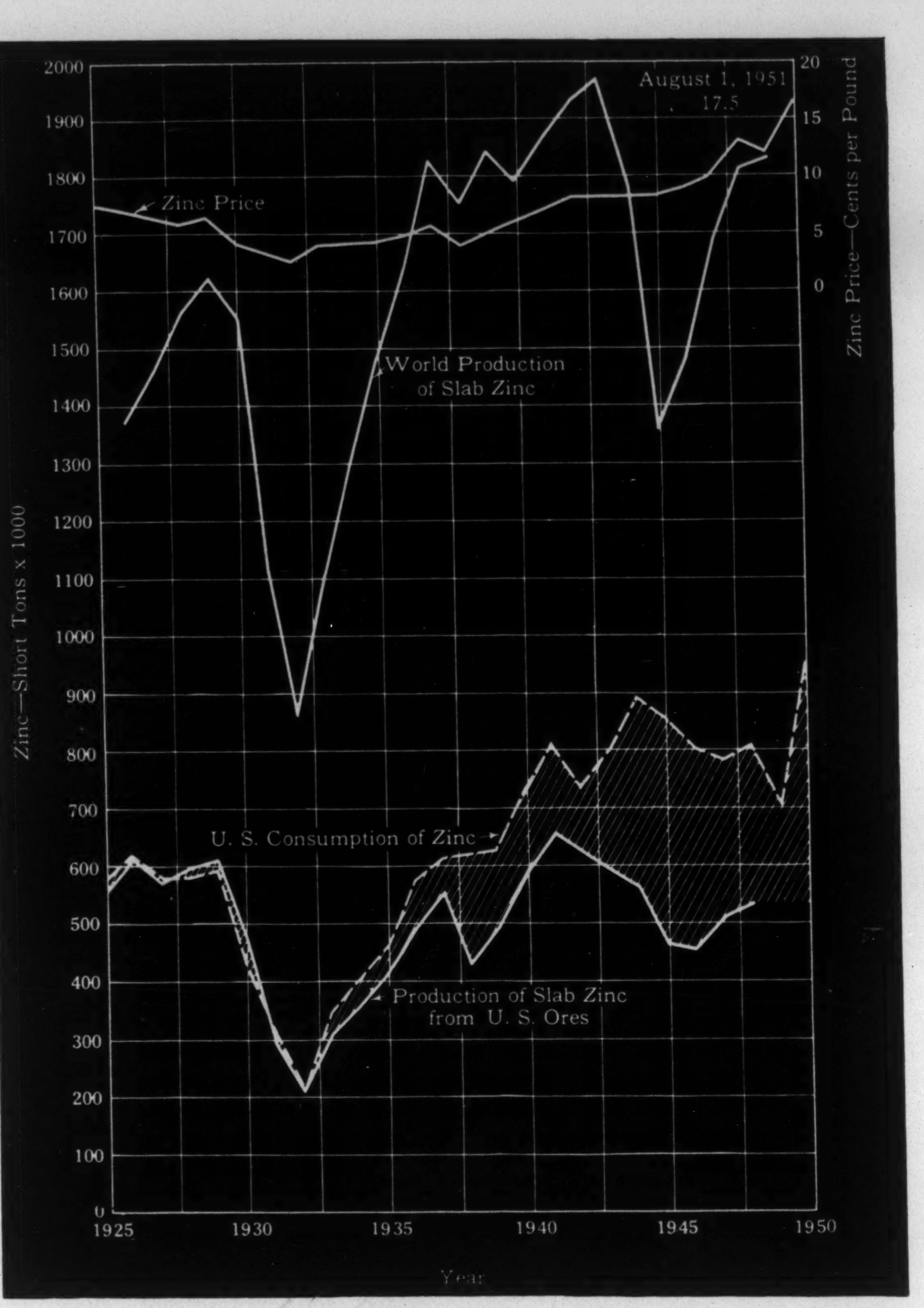
In general, the ores of the Tri-State area are low grade (recovery 1.66 zinc, 0.69% lead). They are characterized by simple mineralization and lend themselves to larger scale, lower cost mining than the Eastern ores, which are of higher grade (recovery, 4.87 zinc, 0.32% lead). The deposits of the Western states are higher grade (recovery, 4.86 zinc, 3.20% lead) and contain worthwhile quantities of gold and silver. But these advantages are offset by complexities of the ores—generally higher production costs, remoteness from markets.

Zinc Reserves

The United States and the world still have lots of zinc, as the table shows. Statements of mineral reserves must always be hedged with qualifications, many contingent on price level, state of mining and ore-dressing technology, extent of exploration, and character of the deposits. This is particularly true of zinc, which occurs, in general, in two types of deposits. In one, zinc is found in more or less vertical veins in the rock and in the other in sloping limestone beds into which the sphalerite (zinc sulfide) has been carried and precipitated from solution in the earth waters. In both cases the zinc ore bodies are often continuous, and the boundaries are extremely difficult to delineate except by expensive drilling. In this respect zinc deposits are more difficult to estimate than, for example, those of porphyry copper, which, by comparison, are uniform and have more definite boundaries.

With these qualifications, the proved and indicated (but not inferred) zinc reserves of the United States in terms of gross content of zinc workable under conditions similar to those prevailing in 1949 are estimated by the United States Geological Survey as 8.5 million tons. Of this, about three-fourths, or something over 6 million tons, should be recoverable. If one were to divide this figure by the 1950 rate of production, one would come up with the startling figure of ten years. However, we can be sure that zinc mines will be producing in this country many years hence, as probably the total zinc yet to be developed by exploration and brought out of mines in this country will total several times 6 million tons. It is simply not good economics to invest money in proving up zinc ore many years in advance of the need for this information in planning for mining.

Although the proportion of the world's zinc that the United States provides is interesting, two other matters are more important: (a) how much of what we need do we produce, and (b) what is the quality and quantity of our reserves? The answer to one is easy to set down; the other is not.



Price, production and consumption of zinc during the period of 1925 to 1950.

Whereas the United States produces a third of the world's zinc, it normally consumes a little over 40% (1946-49, 42.6%). Clearly this leaves a deficit that must be made up by imports and scrap. In the last five years this has amounted to a net average importation of 315,000 tons of contained zinc per year, or about 38% of our consumption. Furthermore, demand for zinc, particularly since July 1950, is rising faster than the ability to produce it. The supply of secondary (reused) zinc has been small, less than 10% of the total consumption, largely because when used for galvanizing—the largest application — the zinc is never recaptured. However, with the increase in zinc die casting, the amount of zinc returned in the future as scrap will increase.

As matters stood at the beginning of this year, based on figures for the first four months of 1950, United States' mines were producing at the annual rate of 700,000 tons. (Previous mine production peaks were 775,000 tons in 1926 and 768,000 tons in 1942.) Consumption for 1951, if the January-April use rate continues, will be about 900,000. Consumption while the emergency lasts will be federally controlled.

Vigorous effects are being made to increase production. The Government is lending encouragement and financial assistance for exploration, allowing rapid amortization of the cost of new production facilities, and facilitating the obtaining of loans for expansion of plants. Once abandoned and now flooded mines may be pumped out and zinc and lead mining resumed with federal aid. It is believed that by these measures the amount of zinc produced from United States' ores this year will be 10% more than last, and in another two or three years mine output will have increased another 10 to 15%. This would bring this country's mine out-

U. S. Consumption of Slab Zinc Annual Average—Short Tons

	Galvanizing	Brass	Rolled Zinc	Die Casting	Others	Total
1926–1930 Prosperity Era	273,600	163,800	70,720	23,800	51,500	583,420
1931–1935 Depression	154,400	93,600	45,600	30,100	36,340	360,040
1936–1940 Recovery	251,600	168,600	55,800	81,600	34,000	591,600
1941–1945 World War II	290,780	338,680	71,520	99,320	23,040	823,340
1946–1950 Postwar	366,939	118,259	72,526	228,016	22,387	811,127

Proved and Indicated Zinc Reserves of the World Workable Under 1949 Conditions

	Gross Zinc, Million Short Tons
United States	8.5
Other North America	8.0
South America	12.0
Western Europe	8.5
Eastern Europe	11.0*
Africa	4.0
Asia	4.0
Australia	14.0
World Total	70.0

** Of which about one half is estimated for U.S.S.R.*

put by 1954 to between 735,000 and 770,000 tons, taking declining grade into account. There is no prospect that the United States will become wholly self-sufficient as to zinc.

All zinc ore produced in United States' mines goes mostly to smelters in Texas, Oklahoma, Illinois, Pennsylvania, Montana and Idaho. In addition to importing slab zinc, the United States also receives zinc-sulfide concentrates from foreign sources. These must be processed in United States' smelters. Hence, smelter capacity exceeds mine capacity by about a third. The smelters of this country can now turn out about a million tons of slab zinc annually. Mines and imports represent the bottleneck to zinc production, not United States smelter capacity.

Zinc Consumption

The curve of zinc consumption in the United States since 1900 is both smooth and steeply rising, with no hint at leveling off. Most old uses are growing and new ones are continually added.

The largest single use of zinc—hot-dip galvanizing—arises out of zinc's unusual anti-corrosion properties. Applied as a surface layer to steel, it prevents corrosion in two ways. Zinc exposed to normal atmospheres forms an insoluble, adherent, impervious layer of zinc carbonate that resists further attack. Also, in the electrochemical series zinc is positive with respect to iron. Hence, when a galvanized article is subjected to electrolysis the zinc is sacrificed for the iron. Even if spots of bare metal are exposed, the nearby zinc will protect against consuming galvanic currents.

Galvanizing absorbs about 45% of the total slab zinc consumption. Galvanizing is one of the oldest of zinc uses. In the first four postwar years consumption of zinc for galvanizing averaged 350,000 tons yearly. In 1950 the total so used was 434,000 tons.

The second largest class of zinc usage is for die castings. This is the most rapidly growing use for zinc, particularly since the war. Since 1946 it has totaled a little more than 200,000 tons per year, or a little over one-fourth of the total consumption.

Zinc die casting began coming into its own about 20 years ago when special high-grade (99.99+ %) was developed. Zinc of this high purity makes possible die-casting alloys of controlled quality. Die casting requires a good structural metal that can be melted and used at low temperature, has little shrinkage, is dimensionally stable, and freezes to a smooth finish without gas inclusions. Zinc die castings—which are at least 94% zinc—are used to provide parts as small as zipper elements (sometimes cast directly onto the fabric) or as large as automobile radiator grilles. Castings can be made of complex shapes, such as gasoline-engine carburetors, requiring close and exactly held tolerances and requiring little or no subsequent machining. Literally thousands of parts of everyday articles are made of die-case zinc: automobile door handles, washing-machine parts, building hardware, tools, toys, novelties, parking meters, typewriters, cameras, frames, etc.

Brass making has taken large quantities of zinc, but this demand has fallen off sharply since the last war. Brass, on the average, is 30 zinc, 70% copper; red brass is 15 zinc, 85% copper. In the prewar years the amount of zinc used for brass ran to about 150,000 tons, or nearly a fourth of the total consumption. World War II, with its demand for brass cartridge and shell cases and other military articles, skyrocketed the need for brass. However, zinc used for brass has dropped steadily from 120,000 tons in 1946 to 85,000 tons in 1949, the consumption for brass averaging about 15% of the total. The new defense program will, of course, reverse this trend.

The low strength of zinc limits its use unalloyed, except in sheet and rolled forms. This use amounts to less than 10% of the total. Such uses include the cases (and negative terminal) of dry cells, fruit-jar caps, weather stripping, photoengraving plates, and as salt-resisting plates on vessels.

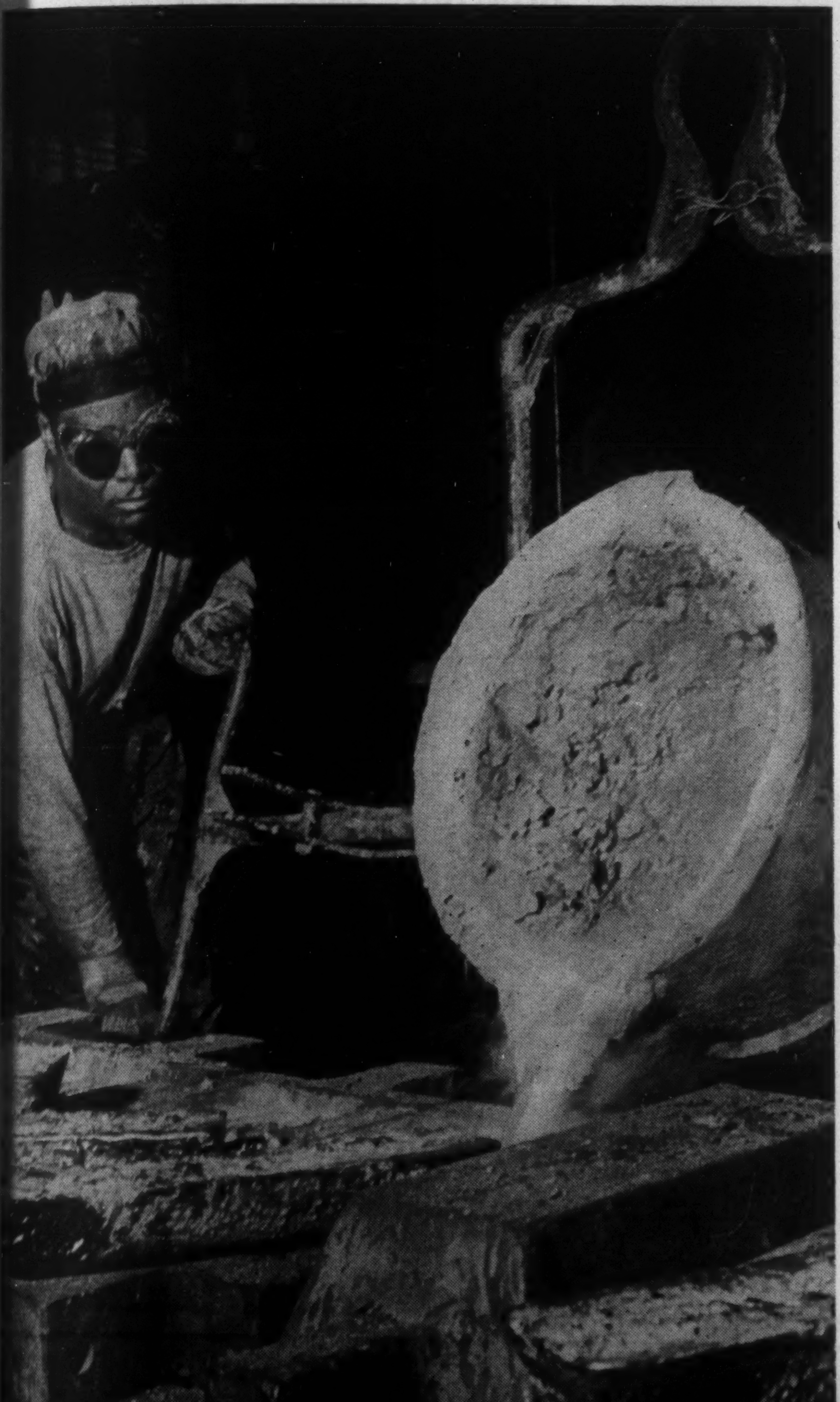
Zinc compounds, of which the chief is zinc oxide, have literally hundreds of uses. Although the average consumption of zinc oxide made from metal came in the four postwar years to only about 16,000 tons, or roughly 2% of the total in average years, over 100,000 tons of zinc in concentrates are converted by the American process into zinc oxide. Few are aware of the variety of everyday uses of zinc compounds. Take zinc oxide itself. Its principal uses are in rubber, paint, ceramics, coated fabrics, textiles, floor coverings, pharmaceutical chemicals, printing ink, dental cement, soap, glue, matches, and tailors' chalk. Zinc chlorides are used as preservatives and for flame-proofing of wood poles and railroad ties. Lithopone, a mixture of zinc sulfate and barium sulfate, is used because of its higher hiding power in interior wall paints of many types including resin-oil emulsion and the newly popular latex paints, industrial enamels, road-marking paint, and is used in inlaid linoleums. Zinc sulfate, made directly from sphalerite concentrate, is used in glue, rayon sizing, electrogalvanizing solutions, insecticides, fungicides, soaps, salts, fertilizers, pigments, dry colors, and as a preservative in casein products.

Zinc dust has some use directly. In sherardizing, for example, a metal part to be coated is heated with zinc dust in a revolving closed chamber. Zinc vapor, given off below the melting point, condenses on the article, forming a uniform, adherent protective coat. Zinc dust imparts highly desirable rust inhibition properties to paints for iron and steel surfaces.

There are but a few adequate substitutes for zinc, and mostly they, too, are currently in short supply. No metal has yet been substituted for zinc in galvanizing; some other bare metal, such as aluminum or magnesium, must be resorted to in peacetime for coating metals if one is not willing to put up with frequent painting. Aluminum and magnesium are competitive to brass, making great progress. Any long lasting differential of about 3¢ per lb in favor of aluminum over zinc would undoubtedly throw a large share of die casting to aluminum. Magnesium could quite possibly be used, perhaps with advantage, in place of zinc, for photoengraving plates.

Zinc, in our present industrial economy, is well-nigh indispensable. Unfortunately, our reserves are by no means inexhaustible.

Information for this article was provided by the U. S. Bureau of Mines, American Zinc Institute, U. S. Geological Survey, and Westinghouse



Casting zinc in the foundry. The second largest use of zinc is for castings.

Shown here is a zinc metallizing operation used for protecting capacitor cases.

Welding Unstabilized Austenitic Stainless Steels Without Carbide Precipitation

by **J. A. GOODFORD**, Chief Welding Engineer, and **D. W. KAUFMANN**, Metallurgist, Crucible Steel Co. of America

Rapid cooling a weld with a water stream.

Two men weld cooling with water.

Rapid cooling of heat-affected zone promptly after welding reduces chances of subsequent intergranular corrosion.

● COLUMBIUM, THE MOST effective stabilizing element for austenitic stainless steels, is so scarce today that it can be used only for the most important defense projects and then only when no alternate is available. As a result of this scarcity, AISI types 347 and columbium-stabilized 309 and 316 are disappearing from the shelf, not only as sheets, plates and strips, but as welding electrodes as well.

Type 321, stabilized with titanium, is satisfactory for many applications where 347 has been used. However titanium's reluctance to cross the welding arc restricts its use in electrodes. Also, this element is rarely found in types 309 and 316. Substitute materials have been produced by reducing the carbon content in types 304 and 316 to a very low level. These steels are reported to be sufficiently low in carbon to permit long time heating in the so-called danger zone of temperature with little possibility of subsequent intergranular attack. Unfortunately, these steels are not too readily available.

The Problem

For applications not involving high temperature service, the only reason for adding stabilizing elements, such as columbium, tantalum or titanium, to stainless steel (or the only reason for reducing the carbon content to a very low level) is to prevent the precipitation of chromium carbides during welding.

This reaction may occur in unstabilized stainless steels during welding in the heat-affected zone adjacent to the weld when the metal is allowed to remain in the temperature range of about 800 to 1500 F for more than a minute or two. If this happens, then the affected zone may be subject to excessive corrosion attack when it is exposed to severe corrosive conditions. Conversely, if the weld metal does not remain in the 800 to 1500 F danger zone of temperature too long, the likelihood of subsequent intergranular attack is greatly reduced.

The Solution

If the weld area is immersed in water as promptly as possible after the weld has been made, or at frequent intervals during welding, it can be cooled to below 800 F in time to prevent serious carbide precipitation. The water can be applied from a hose or by swabbing with wet waste or rag, as shown in the accompanying illustrations. With a hose it can be applied continuously either as a spray or in a steady stream. If the welder requires the use of both hands, a helper can apply the water. Swabbing is likewise adaptable to one- or two-man operation.

The water should be applied within a minute or so after the arc has been established—the sooner, the better. As a rule of thumb, with normal flat position current setting, a standard length electrode is consumed in about 1 min. Therefore, in ordinary manual welding, the welder should apply the water at least as soon as each electrode stub has been discarded, or oftener if desired. The spraying or swabbing should be continued until all color disappears. The weld *can* be cooled to room temperature, but it is usually desirable to leave enough heat to evaporate the water in the weld crater. Otherwise, porosity may develop when the arc is restruck.

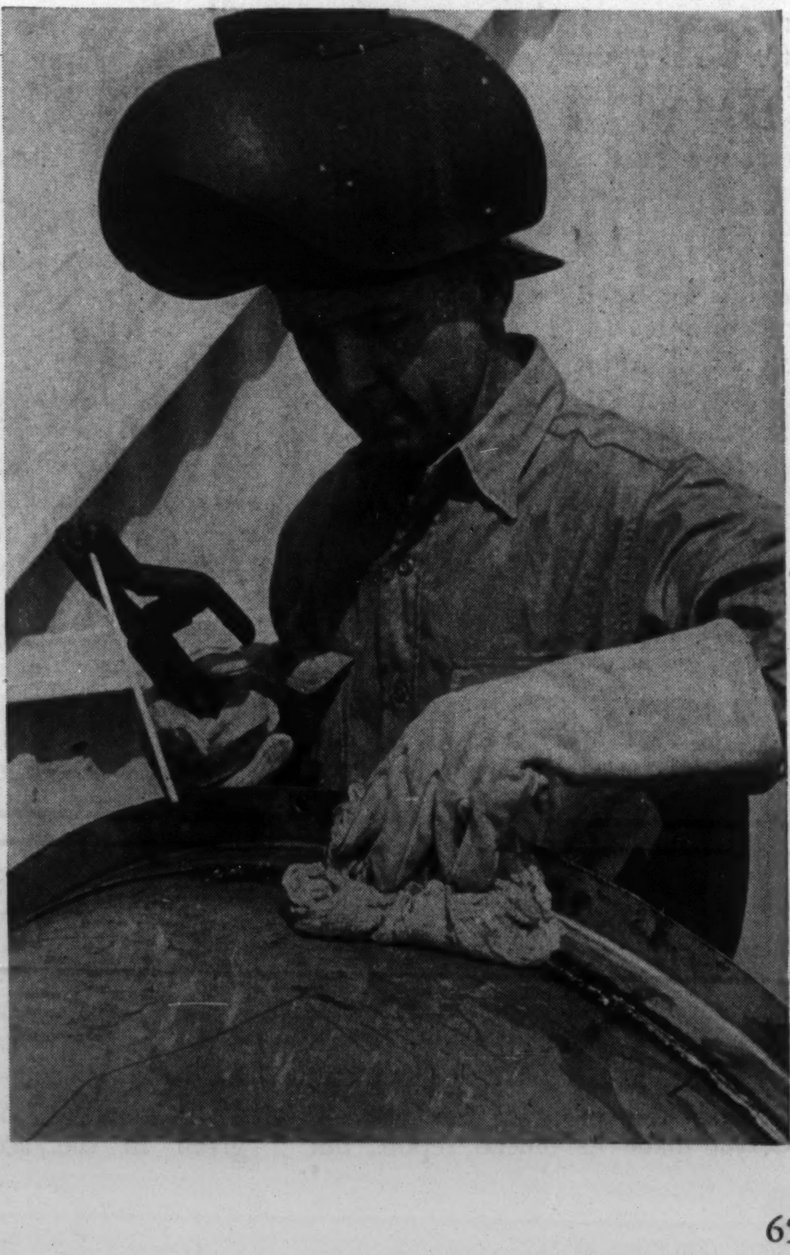
The reasons for the rapid cooling of welds are readily apparent. From the very important standpoint of economics, Types 302, 304, 316 and similar grades can be used rather than the more expensive stabilized or extra low carbon varieties. Flexibility of procurement of raw materials, both parent metal and welding rod, is greatly improved. This is particularly important when special steels are so scarce.

Water cooling can be employed with all types of welding equipment used for stainless steel welding. Water cooling can be applied to all thicknesses and sections. In the welding of thin sheets, satisfactory cooling can be obtained with an air blast.

It is also very beneficial to water cool austenitic stainless steel during cutting operations employing gas or electric arc cutting procedures. It is considered good practice to water cool welds involving stabilized grades when multiple-pass welding of heavy sections is required. This is a further guarantee of maximum corrosion resistance.

Rapid weld cooling using a water-soaked swab.

Rapid cooling a weld by swabbing immediately after welding.



Heat Treating the Carburizing Grades of Boron Steels

by **KENNETH ROSE,** Western Editor, Materials & Methods

Avoiding excessive core hardenability and obtaining satisfactory case hardness in large section parts are the major problems in the treatment of these grades.

● PRESENT AND IMPENDING scarcities of alloy steels, and present and threatened restrictive orders, are causing a reexamination of the "emergency" steels and, in particular, the boron steels that were developed during World War II. This time the situation is both easier and more difficult. Industry has been able to study more thoroughly the heat treating procedures and their results, and has the benefit of the experience of users both during and after the war.

The situation is complicated, however, by the fact that civilian production of many articles is continuing, and requires a wider use of the new steels, and also by the shortage of molybdenum, which was substituted for nickel in many wartime compositions. Restrictions upon the use of both nickel and molybdenum mean that the most widely used grades of engineering steels will be unavailable or limited in use, and that steels of very low alloy content, with hardenability increased by boron, must be called upon for most purposes. At present there are steels available that follow the pattern of the triple alloy or N.E. steels, and include the 81XX series, the 86XX series, as well as the 41XX series, but these are designated as interim alternate steels, and might not be available in a time of national emergency.

Large manufacturing companies and engineering societies are at present studying the use of the boron steels so as to make best use of these grades. The automotive industry, one of the largest users of engineering steels, has made comprehensive studies of heat treating procedures, and the Society of Automotive Engineers has appointed a special subcommittee to outline work to be done and to correlate results obtained in the industry's laboratories. This subcommittee, headed by Harry Knowlton, of International Harvester Co., has not yet made its official report, but unofficial progress reports constitute some of the best information available about use of boron steels.

The action of boron in increasing the hardenability of steel is not yet clearly understood, but several facts about it are generally agreed upon. These are:

1. Very small quantities of boron are required. Hardenability is increased by boron in amounts as small as 0.0004 to 0.0008%. Larger amounts do not further increase the hardenability of the steel. Some metallurgists are of the opinion that boron in amounts above about 0.0015% tend to cause hot shortness in steel.

2. Boron does not act as an alloying element in the usual sense, but rather as a treatment. The very small quantities involved would be insufficient to produce any considerable effect as an alloying element. Boron seems to act by retarding the start of austenite decomposition, perhaps by inhibiting the formation of nuclei at which the decomposition begins.

3. It is agreed that boron is most effective in low-carbon steels, and that the rate of increase in hardenability falls off as the carbon content of the steel increases.

Metallurgists and materials engineers recognize two groups of boron steels from the materials selection and heat treating standpoint, with different problems involved in the use of each group. The first group includes the boron steels in the medium-carbon range (35 to 65 points of carbon) which show good hardenability with the usual heat treating procedures. The second group, the carburizing grades, must be used with due consideration for their special characteristics.

This article is chiefly concerned with the heat treatment of the carburizing grades. Those listed as standard (July 1951) by AISI are given in the accompanying table.

[For complete listing of all the boron steels and other "emergency" grades, see MATERIALS & METHODS, Oct. 1951, pp 135 and 137. *The Editors*]

The carburizing grades of the 80BXX series are intended for gears and pinions to replace steels of the 86XX series. Grades TS94B17 and TS94B20 are primarily for heavy-duty gears or other pieces of large size to be carburized and are intended to replace some of the 48XX series steels.

Heat Treating Problems

Problems in the use of the carburizing grades of boron steels seem to center about two difficulties. One of these is excessive hardenability of the core, which can result in warping and distortion. The other is the difficulty in obtaining sufficient hardenability in the case to guarantee surface hardness of large sections.

With the medium-carbon steels the effect of boron is lessened because of the higher percentage of carbon present, and hardenability is not excessive. However, with the carburizing grades the boron has considerable effect in the low-carbon core, decreasing effect at the inner portion of the carburized zone, and little or no effect at the outer portion of the carburized zone.

The usual quenching practice to develop the required hardness in the case can result in over-hardening of the core, while changing the quenching procedure so as to reduce the core hardness can cause the surface hardness to fall below the desired value.

The matter of excessive hardenability hinges upon the form of the hardenability curves for boron steels. The curves follow a general pattern in which the first few 16ths show good hardenability with rather narrow limits, and the hardenability then drops off more rapidly than that for the alloy steels, with the limits broadening. Translating the values of the curve in terms of surface hardness and size of workpiece, small pieces made of boron steels will show good hardness after proper quenching—in fact, hardness may be excessive; pieces of medium size, but of a diameter not exceeding the "ideal diameter" indicated by the break in the curve, will quench out; and pieces of larger diameter will not quench out with normal quench. It is important to remember that the hardenability curve for the boron steel is fundamentally different from that of the alloy steel it is replacing, and to make sure that the ideal diameter indicated by the curve does not differ too much from the diameter of the workpiece.

Excessive hardening in the core and lack of hardness at the surface can be overcome by three methods:

Changing the alloy content—in the 80BXX series, for example, manganese content can be increased from 0.45 to 0.60% to 0.60 to 0.90% in the carburizing grades to provide increased hardness at the surface of the piece, where boron is ineffective. The boron takes care of core hardness. A new series of steels, containing neither nickel nor molybdenum, but with manganese increased about 0.30%, has been produced. These steels, now designated as the 14BXX series, are essentially plain carbon steels of the 10XX series with boron added to increase the hardenability for core hardness, and with the increased manganese content to take care of surface hardness where the boron is found to be ineffective.

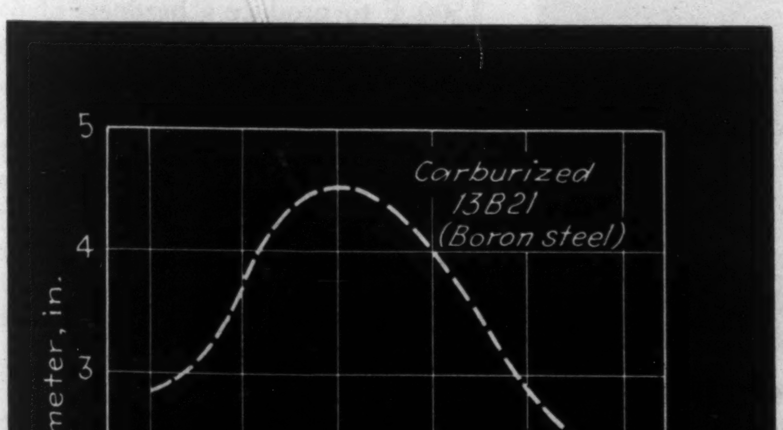
It is generally agreed that boron, while a valuable treatment for increasing the hardenability of steel, cannot be regarded as a substitute for all the alloying elements in engineering steels. Just how much alloy is absolutely necessary as a minimum in steels for various purposes is a matter that has been receiving the attention of many of the leading practical metallurgists in the country. At a recent informal meeting of some of these metallurgists, it was decided that for gears, the steel must have sufficient alloy content to guarantee a surface hardness of 57 Rockwell C on the teeth down to the root.

Reducing the carbon content—Users of boron steels in carburizing grades have shown a tendency to go to lower carbon contents, such as the 15- and 17-point compositions, to avoid the warping resulting from too great hardenability. These grades carry a price premium. A leading metallurgist who has been using boron steels during and since the war states that they can be used at a higher core hardness than alloy steels so far as any danger of brittleness is concerned, as the boron steels have greater ductility at the same hardness. Others believe that the so-called brittle failures of case hardened parts are due to excessive tensile stresses in the surface which are set up by hardening of the core, and not due to inherent toughness or brittleness of the core itself. This matter is, of course, controversial at this time.

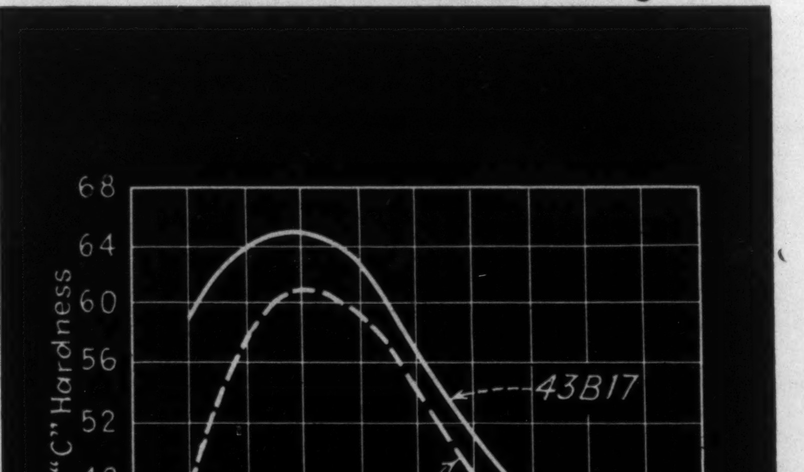
Metallurgists experimenting with the boron steels as alternate materials for higher-alloyed steels have found that several compositions providing a range of carbon contents may be an answer to the excessive hardening of one type in certain applications.

Slowing the cooling rate—By quenching into a bath held at elevated temperature the cooling rate is reduced, and the tendency to excessive hardening is reduced also. The same result is achieved by quenching from a lower temperature. This can be the simplest means of dealing with excessive hardenability, inasmuch as it requires only modification of the heat treatment, whereas the two preceding methods require purchase of different steels, not always possible in times of short supply.

Insufficient hardening can usually be corrected by increasing the agitation of the quenching medium. A more drastic quenching medium might be necessary if hardening should be considerably below requirements. The problem of warpage may arise if too drastic a quenching procedure is used, however.



Hardenability effect of boron decreases with increasing carbon content. When case of this boron steel is carburized to above 1% carbon, hardening properties are similar to that of base composition. (Wray, United States Steel Co.)



Hardness gradient in case after direct quenching of 43B17 steel as compared to standard 3310 grade. (Wray, United States Steel Co.)

Users' Experience

At Ford Motor Co., procedures have been worked out that give satisfactory results with 80B20 steel for larger gears and smaller parts in which distortion was not critical. When 80B20 steel was tried for smaller gears, excessive warpage was encountered due to too high a hardenability. Experimental processing indicated that lowering of the quench temperature and quenching into molten salts, followed by a stress relieving treatment, successfully eliminated this warpage. However, it is not always possible to change established processing because of limitations in space and availability of equipment. Consequently, work is being continued on steels of lower hardenability. It was the opinion of members of the Chemical Engineering Dept. that 81XX series steels could be more successfully used for carburizing applications in relatively light sections.

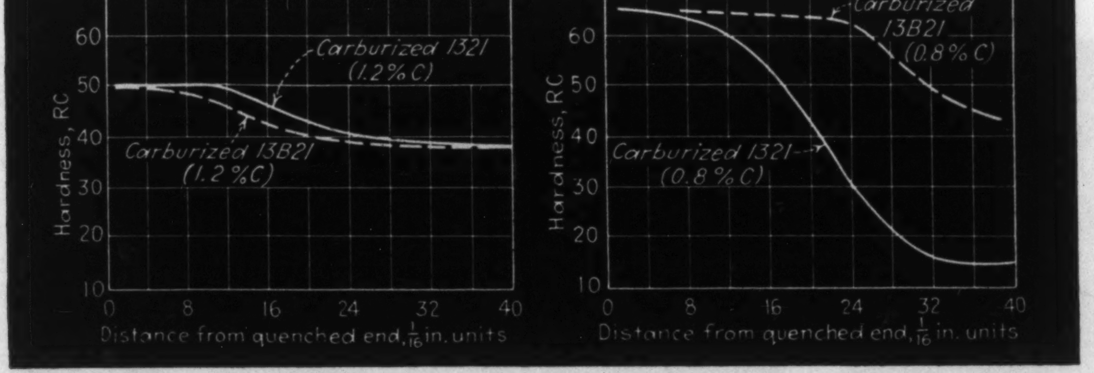
At Timken-Detroit Axle Div. the chief metallurgist, Roy W. Roush, has been using boron steels in the 94BXX group for heavy gears and other large pieces. He stated that the company had tried 94B20 steel for some of its parts and had switched to 94B17 steel to reduce the hardenability slightly. While it might have been preferably on a theoretical basis to use 94B15 for small gears, 94B17 for somewhat larger pieces, and 94B20 for large, heavy-duty gears and other parts, it was more practical to standardize upon 94B17 steel for all gears and to adjust the heat treatment to suit the work. The basic treatment used is to gas carburize at 1700 F, to quench from about 1650 F immediately afterward into oil at about 150 F. All ring gears are pressure quenched, with forced circulation of oil. The boron steel is replacing 4620 steel for gears.

One of the difficulties in hardening gears is that the piece shrinks in on the bore. This may be overcome by broaching oversize to compensate for shrinkage, or by quenching on a spud. Timken-Detroit has been developing a case depth of about 0.090 in. in large gears and about 0.040 in. in smaller sizes. It is important to avoid excessive carbon concentration in the surface of the work; peak hardenability occurs with a carbon content of about 88 points, and the surface carbon content should be held to 85 to 95 points.

Timken-Detroit has been using some of the noncarburizing grades of boron steels successfully, including the 14B38 steel for axle shafts and tractor draw bars. This steel is replacing relatively mild steels — 86XX types and 5145 for axles, and 51XX series steels for bolts. For axles the steel is quenched from 1550 F into oil, then drawn back to the desired hardness. Bolts are quenched from 1600 F into oil. The 94B30 type is used for front axle centers, steering arms, and knuckles. It is water-quenched from 1550 F and drawn back to a hardness of about 269-321 Bhn. This steel is replacing 8630, 4130 and some 3130 steels. Type 94B40 is used for a torque rod ball, replacing 4340 steel. It is quenched from 1550 F into oil and drawn back to the desired hardness.

William J. Day, of Mack Manufacturing Co., has been using another modification of boron steel to replace 4820 steel. His 43BV14 is a low-carbon carburizing steel with 0.03 to 0.09% vanadium added. The vanadium serves to reduce grain growth during the long carburizing cycle, sometimes as long as 20 hr, and also flattens the top of the hardenability curve. This steel is used for all types of gears, including heavy-duty truck gears. It is quenched from 1450 F to 1500 F to produce a hardness of 65 Rockwell C, and the work is then drawn back to 60 to 62 Rockwell C. Quenching from the low temperature reduces the danger of excessive hardening. Mack Manufacturing is using 94B17 also, and is quenching this steel from 1450 F to prevent excessive hardening. The company had started with a 43BV17, but found that the lower-carbon steel gave better results.

The Wisconsin Steel Div. of the International Harvester Co. has developed a complete series of 50BXX steels, which are fundamentally 0.40 to 0.60 chromium steels with the addition of Grainal #79. At the present time these are in various stages of transition from experimental tests to actual full scale production use. In general, the highest carbon grade is designed for springs, 0.40 to 0.50 carbon grades are used for axles, bolts and forgings requiring heat treatment, while the lower carbon grades are used for case hardened gears. Typical parts from these general classes have been subjected to engineering tests before the material is approved for production.



The curves, left, show hardenability of 1321 and 13B21 at 1.20% carbon as compared to hardenability of same steels at 0.80% carbon, right. (Wray, United States Steel Co.)

Carburizing Grades of Boron Steels

	Composition, %					
Grade	**C**	**Mn**	**Si**	**Cr**	**Ni**	**Mo**
50B15	0.12–0.18	0.70–1.00	0.20–0.35	0.35–0.60	——	——
50B20	0.17–0.23	0.70–1.00	0.20–0.35	0.35–0.60	——	——
80B15	0.12–0.18	0.60–0.90	0.20–0.35	0.15–0.35	0.20–0.40	0.08–0.15
80B17	0.14–0.20	0.60–0.90	0.20–0.35	0.15–0.35	0.20–0.40	0.08–0.15
80B20	0.17–0.23	0.60–0.90	0.20–0.35	0.15–0.35	0.20–0.40	0.08–0.15
80B25	0.21–0.28	0.60–0.90	0.20–0.35	0.15–0.35	0.20–0.40	0.08–0.15
TS94B17	0.15–0.20	0.75–1.00	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
TS94B20	0.17–0.22	0.75–1.00	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15

Microphones Make Good Use of Die Castings

by **L. R. BURROUGHS**, Chief Engineer, Electro-Voice, Inc.

The many different zinc alloy components used in microphone assemblies illustrates the versatility and advantages of die castings.

● MORE THAN 50 different zinc alloy die cast components are used by Electro-Voice, Inc., Buchanan, Mich., primarily in the microphones and accessories that this company manufactures in large quantities. Reasons for using zinc die castings are much the same as the reasons for their use in other electrical and electronic units. Die castings lend themselves to rapid and economical production in an infinite variety of shapes. Surfaces are smooth and easy to finish at moderate cost. As-cast dimensions are held closely, and only light machining is usually needed. Good strength and high shock resistance are attained. Appearance is excellent. Dies are moderate in cost and have long life. Coring is readily and precisely done. Sections can be made as thin as adequate strength and stiffness permit, and can be varied as desired to provide mounting bosses, ribs, reinforcements and the like. Economy in metal is high. Red rust does not occur, and corrosion is easily avoided. Self-fastening features, such as integrally cast threads, studs or rivets or lips that can be spun over, are easily provided.

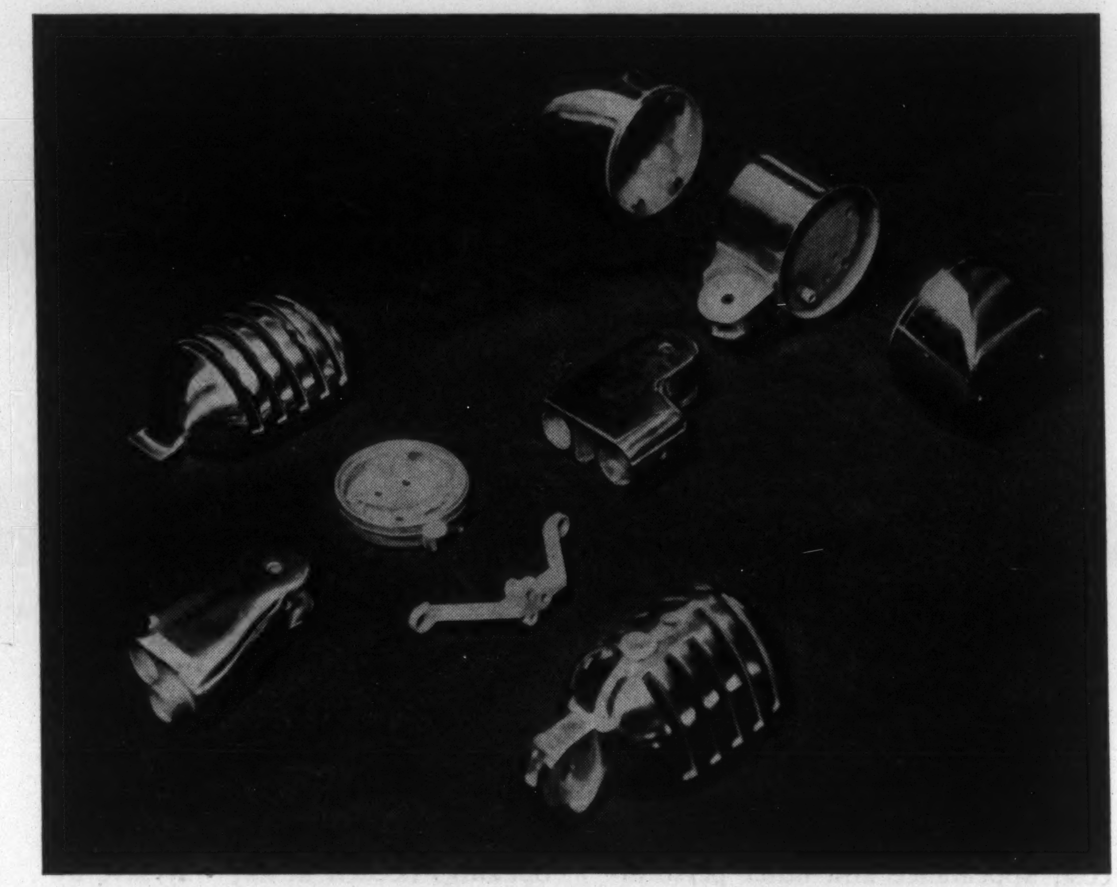


Fig 1—All of these and many other zinc alloy die castings are employed to advantage in microphones of many types that are manufactured by Electro-Voice, Inc. Many of the external parts are plated.

This is an impressive list of advantages and one not matched in several respects by any alternative product. In other words, die castings are "naturals" for the microphone applications chosen and, if other types of product had to be substituted, important advantages would be sacrificed. It does not follow, of course, that other products are not used where they meet specific requirements better or are lower in cost. Thus, many stampings and screw machine products, for example, are combined with die cast components, and plastic moldings are also employed.

Several die castings typical of those used by Electro-Voice are shown in Fig 1 and give a good idea as to the variety of shapes needed. Most of these could not be produced economically, if at all, by any method save casting (unless molded from plastic), and only die castings could be used without excessive machine work. In any other castings, sections would have to be thicker and coring possibilities would be sacrificed; in addition, smoothness would be inferior and finishing would cost much more. Some shapes shown could be molded from plastics but would cost

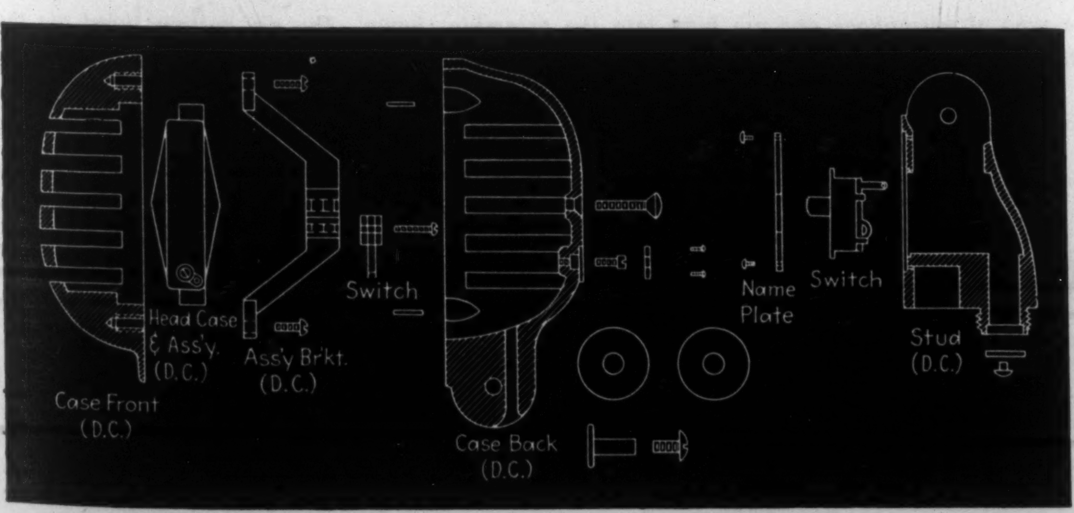


Fig 2—Drawing showing a sectional exploded view of one microphone and its supporting parts. Those marked (D.C.) are zinc alloy die castings.

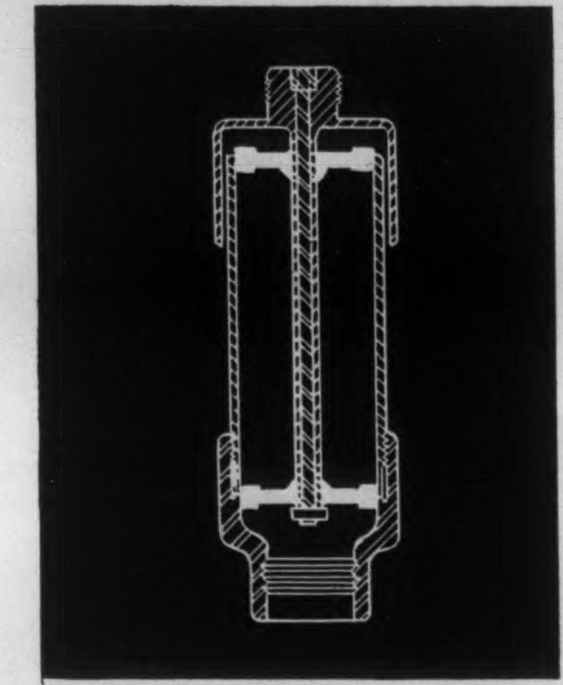


Fig 3—Sectional drawing of a microphone equipped with Lord shock mountings (shown in solid white). The supporting thimble, bottom and the cap at top are the die cast components.

more, and both strength and dimensional stability would be decreased, not to mention other disadvantages.

A better idea as to interior shape and sections for a microphone case and its support is attainable from the drawing, Fig 2, in which the parts marked (D.C.) are zinc alloy die castings. These parts approach the ideal from production, strength, low cost, appearance and other performance standpoints. Grille openings permit sound to reach the microphone itself, and the housing is better in appearance and stronger than if a screen cover were used. The housing and bracket or yoke are also structural elements that support the microphone.

Electro-Voice also makes microphones in which stamped screens provide openings for sound waves to pass. However, the screen merely functions as a covering, and a die cast support for the screens as well as for interior parts is needed. Some types of microphone, such as that shown in section in Fig 3, require Lord shock mountings to avoid the transmission of shock and vibration to the microphone itself. But, in this design, both the supporting thimble and the cap are die castings because they are so conveniently and economically made in the shapes and section thicknesses needed.

Besides housing components and their supports, many interior elements are die cast. Cost is moderate and the precise shapes and openings needed are attained. Castings in the damping chamber assembly shown in Fig 4 constitute a good example. A major die casting in this assembly consists of a flange 1 in. square having a tubular hub-like projection 3/8 in. long at one side. All sections are 1/16 in. or less in thickness. Holes are cored at each corner of the flange and four arc-shaped cored holes pierce the flange just outside the hub, which is reamed inside and threaded outside after casting. The face of the flange opposite to the hub and a shallow annular recess around the hole at the center of this face are machined. This recess is provided to cut across the four arc-shaped holes for reasons explained later. To produce this simple component with the openings needed in any way save by die casting would be expensive.

Also, die cast is the nut that fits the thread cut on the hub. Another form of nut might be used, but this one has six short dome-headed pins on one face. They are cast integrally and provide a convenient means of adjusting and fastening the nut precisely after the two die castings are in place under a steel yoke attached to a circular steel disk to which the casting flange is fastened by four tubular brass rivets. Supported by the stamped steel yoke is an Alnico magnet that fits the reamed bore of the die cast hub.

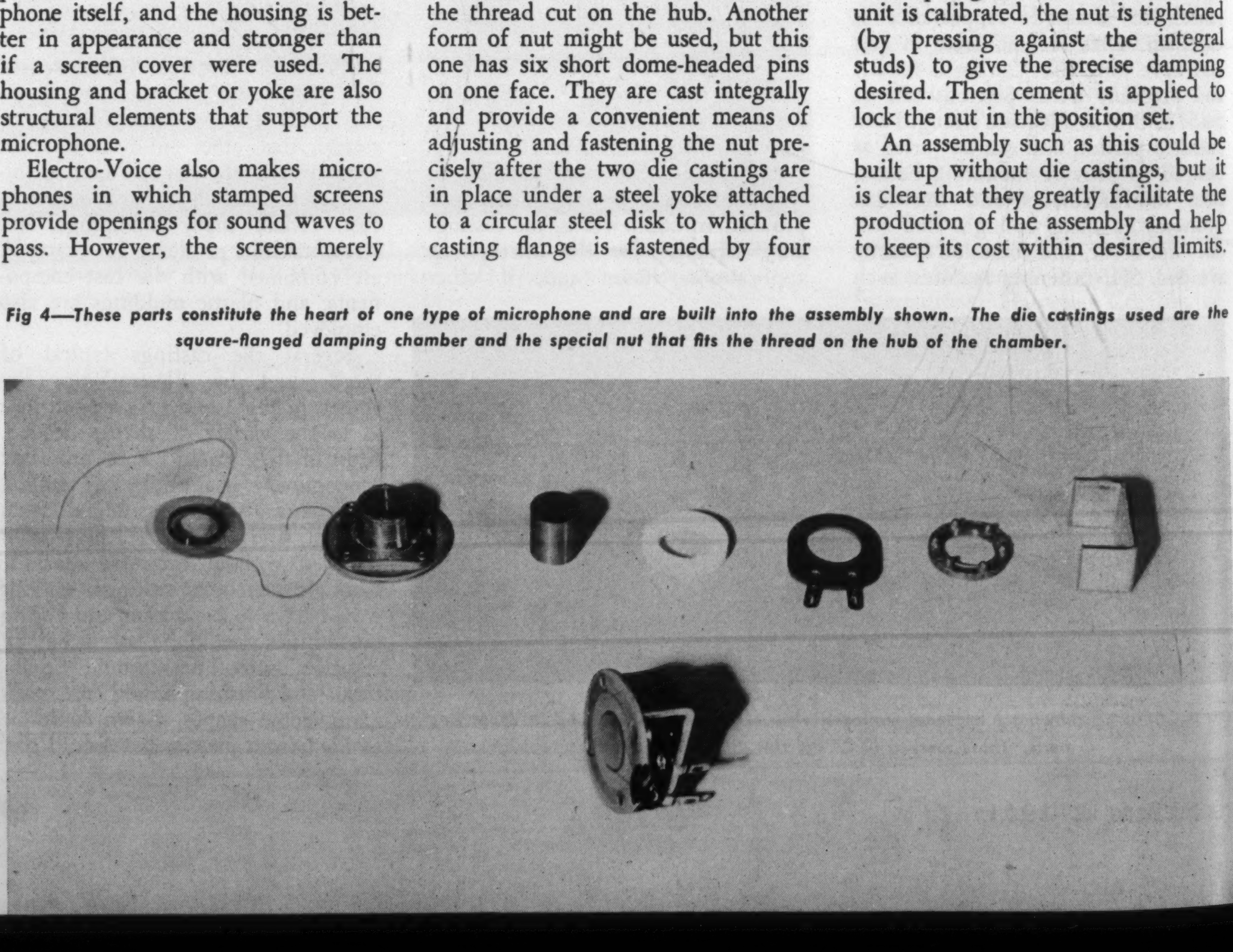
Besides the parts named, the assembly includes a felt washer that fits around the hub and against the flange. This washer seats over the four arc-shaped holes next to the hub. Mounted on the outer face of the stamped steel washer is a special plastic diaphragm to which is attached a self-supporting voice coil. This coil is so arranged as to move with a plunger-like action in the annular magnetic gap between the central hole of the steel washer and the cylindrical magnet.

The motion of the voice coil as it is moved by the diaphragm in the fixed magnetic field generates electrical energy in the coil in accord with the sound waves that actuate the diaphragm. Leads from the coil are brought out and are soldered to two small lugs fastened to the phenolic plate that is clamped between the felt washer and the die cast nut.

As the diaphragm moves, air in the annulus and in the holes connecting to the annulus is forced through pores in the felt that covers the holes. When the nut is tightened, the pores in the felt tend to close, and, the tighter the nut, the less air can pass through the felt in a given time. Thus, the nut provides a means for damping the air flow and correspondingly damping the action of the diaphragm, as desired. When the unit is calibrated, the nut is tightened (by pressing against the integral studs) to give the precise damping desired. Then cement is applied to lock the nut in the position set.

An assembly such as this could be built up without die castings, but it is clear that they greatly facilitate the production of the assembly and help to keep its cost within desired limits.

Fig 4—These parts constitute the heart of one type of microphone and are built into the assembly shown. The die castings used are the square-flanged damping chamber and the special nut that fits the thread on the hub of the chamber.



Group of silicon carbide throat shapes used in rocket motors. (Carborundum Co.)

Silicon Carbide Refractories Used as Alternates for Special Service Alloys

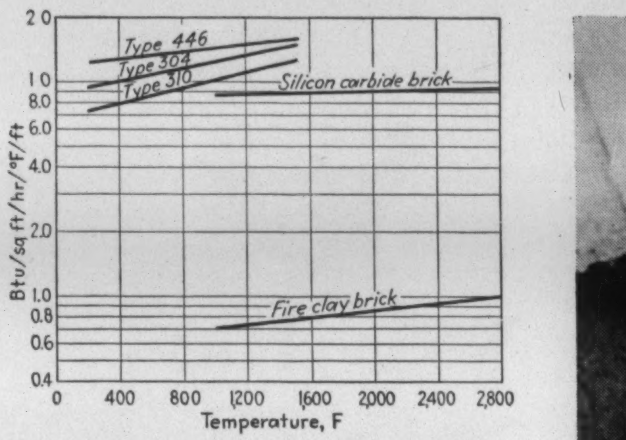
by **JOHN L. EVERHART,** Associate Editor, Materials & Methods

A combination of good elevated temperature properties, and high abrasion and corrosion resistance fits this hard material for numerous applications where strategic alloys were formerly used.

● THE MATERIALS ENGINEER faced with shortages of his usual high temperature alloys has an alternate material available whose components are readily obtainable in this country. This material is a full line of refractories made from silicon carbide. Used as a substitute for heat resisting alloys in World War II, bonded silicon carbide proved so satisfactory in several applications that it displaced the metal permanently. In cost it compares favorably with the stainless steels.

Prepared in the electric furnace at high temperature from a mixture of silica sand and coke, silicon carbide is one of the hardest of man-made materials. When formed into a brick or shape with suitable bonding agents, the product has a number of properties which are unusual in a material thought of primarily as a refractory or an abrasive.

Among these properties are strength, thermal conductivity, abrasion resistance and corrosion resistance. Silicon carbide refractories retain strength and rigidity at temperatures over 2800 F while the heat resisting steels weaken rapidly above 1500 F. The compressive strength is particu-



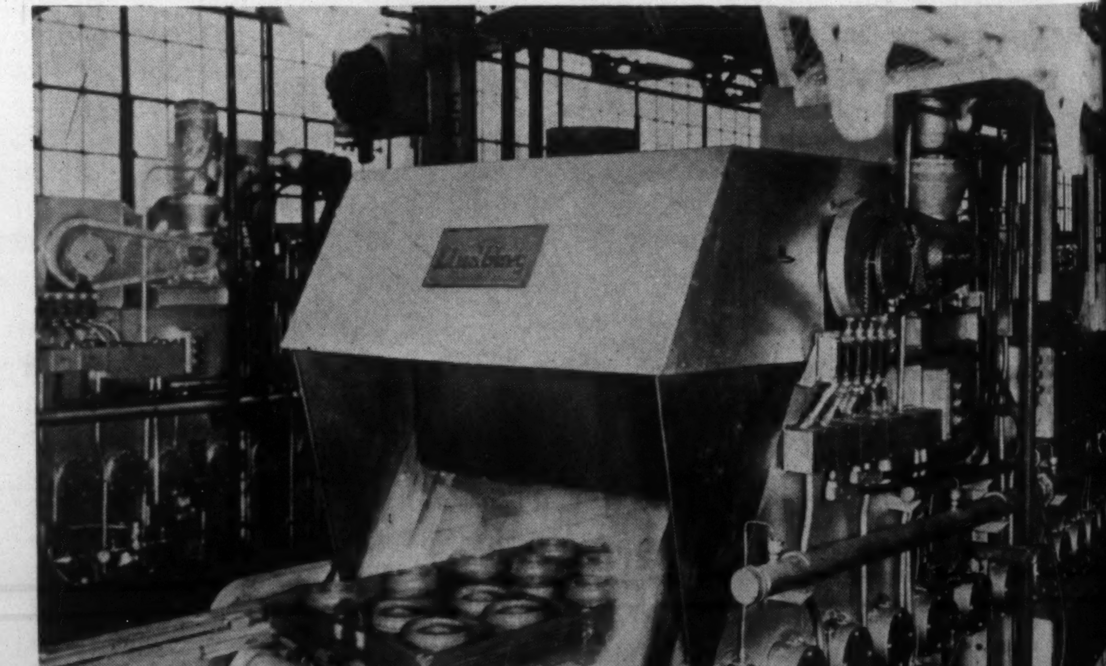
Thermal conductivities of steels and refractory bricks.

larly noteworthy at high temperatures. At 2750 F, silicon carbide brick withstand 300 psi, compared with 25 psi for fire brick. However, hot strength is not usually the only consideration in selecting a material for high temperature service. Silicon carbide refractories are good conductors of heat having ten times the thermal conductivity of fire clay and approaching that of the heat resisting alloys at furnace temperatures. In absorption of heat and emissivity they are superior to the metals. While most refractories are insulators, silicon carbide has electrical properties such that it is employed in the heating elements of high temperature electric furnaces. In addition, it is a hard material which has excellent resistance to abrasion and is resistant to corrosion, particularly by acids and acid salts. Some of the properties of silicon carbide brick, fire clay brick, and several heat resisting steels are given in the accompanying table.

Elevated Temperature Uses

Perhaps one of the best examples of an application requiring resistance to heat is the liner and throat of an uncooled rocket motor. These liners in which the fuel is burned and the throats through which the propellant gases are expelled must withstand high temperatures and severe erosion. Large rocket motors may burn four tons of fuel in 75 sec with an estimated temperature in the throat of 5500 F. If a metal will withstand these severe requirements for 1¼ min, it is considered good. Special silicon carbide refractories have withstood the same conditions many times longer than the metals in some units, and are being applied to rocket motors to replace metal liners and throats. Relatively few engineers are concerned with rocket motor design, however, and the more prosaic applications are probably of more general interest.

Charge end of a pusher type forge heating furnace showing silicon carbide skid rails after 1-yr service. During this period 16,000 tons of steel were pushed through the furnace with a loss by wearing of the silicon carbide of only 1/16 in.



High temperature brazing of automotive parts using silicon carbide fixtures at Chevrolet Div., General Motors Corp.

Another application which is based primarily on resistance to heat is the use of fixtures to hold parts for high temperature brazing. Metal supports were employed in a production brazing operation in which the parts to be brazed were heated in an atmosphere furnace on a cycle from cold to 2100 F to cold in 1½ hr. The fixtures warped badly. Attempts to overcome the warpage by increasing the thickness eventually resulted in the use of supports so heavy that they absorbed a major part of the furnace heat. When the metal holders were replaced with silicon carbide shapes, the life was doubled and sticking of brazing material to the fixture was eliminated. Moreover, the silicon carbide pieces were cheaper than the alloy parts which they replaced.

Metallurgical advances have made necessary the use of special furnace atmospheres in many forging and heat treating operations. There has been a need for an economical means of generating the particular gases required. A number of furnace builders now offer suitable generators as an integral part of their equipment. In these tube-type generators, sulfur in the fuel is corrosive to the chromium-nickel alloys which have been used for tubes. During World War II, one furnace manufacturer was unable to obtain a supply of his alloy tubes and substituted silicon carbide cylinders. Such tubes have proved so satisfactory that this producer has never reverted to alloy tubes for this application while other manufacturers have abandoned alloys in favor of silicon carbide. At present, from 75 to 85% of tube-type gas generators are equipped with silicon carbide tubes. This successful use of tubular products has fostered the application of silicon carbide shapes for such new processes as hydrocarbon reforming.

For the lining of retorts used in the reduction of a number of substances, silicon carbide refractories have proved more satisfactory than heat resisting alloys. Typical examples of such applications are the winning of zinc and other metals from their ores. An idea of the compressive strength of these refractories can be obtained from the dimensions of such retorts. They range from 15 to 30 ft high and have cross-section of 1 by 5 ft. Similarly, in an installation for the heating of carbonaceous material, where a temperature of approximately 2000 F was being used for the desired reaction, alloy steel lasted 2 to 3 months. Replacement of the alloy by bonded silicon carbide increased the life to 15 to 18 months. Furthermore, it was possible to operate at higher temperatures with safety, with the result that the production rate was quadrupled.

Such a performance illustrates one of the most striking features of bonded silicon carbide in process work. Since reaction rates increase markedly with rising temperature, high temperature operation is frequently desirable. While alloys can be used up to approximately 2000 F, silicon carbide refractories can be employed safely as high as 2800 F. Thus, silicon carbide shapes cannot only be substituted for alloys but, as a result of the replacement, increased rates of output can be obtained.

Other applications based primarily on the strength at elevated temperatures and the high thermal conductivity are muffles and radiant tube heaters. Silicon carbide muffles have certain advantages over alloy muffles. These include lower first cost, ready availability, and chemical inertness to sulfur in fuels. They can be operated at higher temperature levels than alloy muffles, thus giving heat release rates considerably superior to those obtained at lower temperatures with the alloys. Silicon carbide muffles up to 20 ft long have been built of 4-ft sections. These muffles, held by compression springs, are tight enough to be used in controlled atmosphere furnaces. In furnaces, which are kept hot continuously, much longer muffles have been built without the use of end compression.

In radiant heat installations, alloy tubes serve at furnace temperatures up to about 1800 F while silicon carbide tubes are used up to 2500 F. This is another application in which the higher operating temperatures possible with silicon carbide parts are advantageous.

In addition to their good thermal conductivities, silicon carbide refractories offer the advantages of greater emissivities and rates of heat absorption. The emissivity of bonded silicon carbide approaches that of a black body while heat resisting alloys are only fair in this respect. Long silicon carbide radiant tubes are built up from short sections using lap or ball-and-socket joints. Because of the high compressive strength of the material, such tubes have been held under 1000 psi end compression at 2200 F in installations which have been in service for several years.

Properties of Several Heat Resisting Steels, Fire Clay Brick, and Silicon Carbide Brick

	Heat Resisting Steels			Refractories	
	304	310	446	Fire Clay Brick	Silicon Carbide Brick
Melting Range, F	2550–2590	2550–2650	2550–2750	*	*
Density, Lb/Cu In.	0.29	0.29	0.27	0.07–0.09	0.092
Thermal Cond. (at Temp indicated), Btu/Hr/Sq Ft/Ft/°F	9.4 (212 F) 12.4 (932 F)	8.0 (212 F) 10.8 (932 F)	12.1 (212 F) 14.1 (932 F)	0.7 (1000 F) 1.0 (2800 F)	8.7 (1000 F) 9.4 (2900 F)
Coef, of Exp., per °F (x10^{-6}) 68 F to Temp Indicated	10.6(1700F)	10.9(2100F)	——	3.0 (2500 F)	2.6 (2500 F)
Spec. Ht., Btu/Lb/°F	0.12	0.12	0.12	0.27	0.28
Max. Service Temp in Air, F					
Continuous Service	1600	1900	2000	——	2800
Intermittent Service	1700	2100	2150	3000	3000
Modulus of Rupture, psi at 2400 F	——	——	——	0–400	800–3100
Refractoriness, Pyrometric Cone Equiv.	——	——	——	31–34	37–40
Emissivity	0.38	0.38	0.38	0.75	0.9

** See pyrometric cone equivalent value*

NOTE:

Cone No.	*Temperature Equivalent, F*	*Cone No.*	*Temperature Equivalent, F*
31	*3056*	*37*	*3308*
32	*3092*	*38*	*3335*
33	*3173*	*39*	*3389*
34	*3200*	*40*	*3425*

Some Applications of Silicon Carbide Refractories

- Rocket motor liners
- Muffles
- Retorts
- Thermocouple protection tubes
- Brazing fixtures
- Radiant heater tubes
- Gas generator tubes
- Skid rails
- Cyclone liners
- Hopper linings
- Throats of chutes
- Coke chutes
- Hot blast mains for blast furnaces
- Blast furnace downcomers
- Cross-overs of water gas generators
- Linings for water gas generators
- Linings of "tee's" and "ell's" in pneumatic systems
- Impellers for centrifugal pumps
- Spray nozzles for handling sulfuric acid
- Tubes for submerged combustion heating of corrosive liquids
- Wire guides
- Roller hearths
- Heating elements for high temperature electric furnaces
- Lighting arresters for high voltage circuits
- Resistors for electronic devices
- Carburizing boxes
- Arc shields
- Checker brick for reforming

Corrosion Resistance Uses

A modification of the radiant heat tube is used for submerged combustion, a process which has been developed in recent years especially for the evaporation or concentration of solutions which are scale-forming or corrosive. In this process, a gaseous fuel is burned in a simple cylinder completely immersed in the liquid and the products of combustion are discharged into the liquid. Ordinarily, corrosion resistant alloy steels are used for these tubes. However, some solutions attack even these materials too rapidly to make the process economically feasible. Silicon carbide tubes have been used successfully for the heating of a number of these very corrosive liquids. These include a solution of mixed chlorides and sulfates of iron, zinc, mercury, tin, etc. containing free acids.

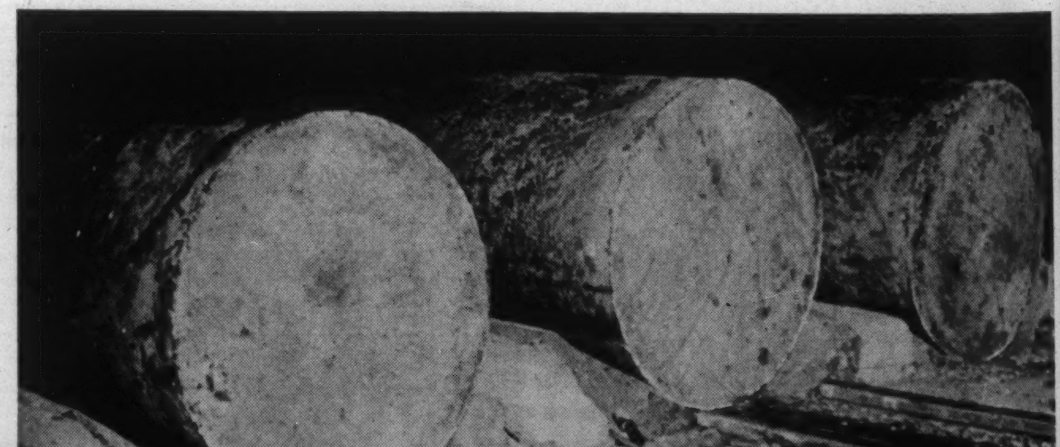
Silicon carbide shapes have been used also to replace alloy steel nozzles in sulfuric acid sludge burning systems. These are applications in which the corrosion resistance of the material is of more importance than its high temperature properties.

The excellent resistance to attack by strongly acid solutions is indicated by the use of silicon carbide for wire guides. These guides are used in pickling and plating tanks to maintain proper spacing and conduct the wire through the solution. An example of such an application is the production of galvanized wire. Alloy steel guides are attacked badly in this service and become coated with a layer of zinc which can interfere with the proper feeding of the wire. Silicon carbide guides resist the corrosive attack by these solutions, do not become coated with zinc and, equally important, resist mechanical wear indefinitely. As a result, such guides are gradually replacing metals in this application.

Wear Resistance Applications

Another of the properties of silicon carbide refractories is resistance to abrasion. This is the foundation of a number of applications, including skid rails, linings for cyclone dust collectors, and impellers for centrifugal pumps. Surprisingly enough, some of these applications do not involve high temperatures.

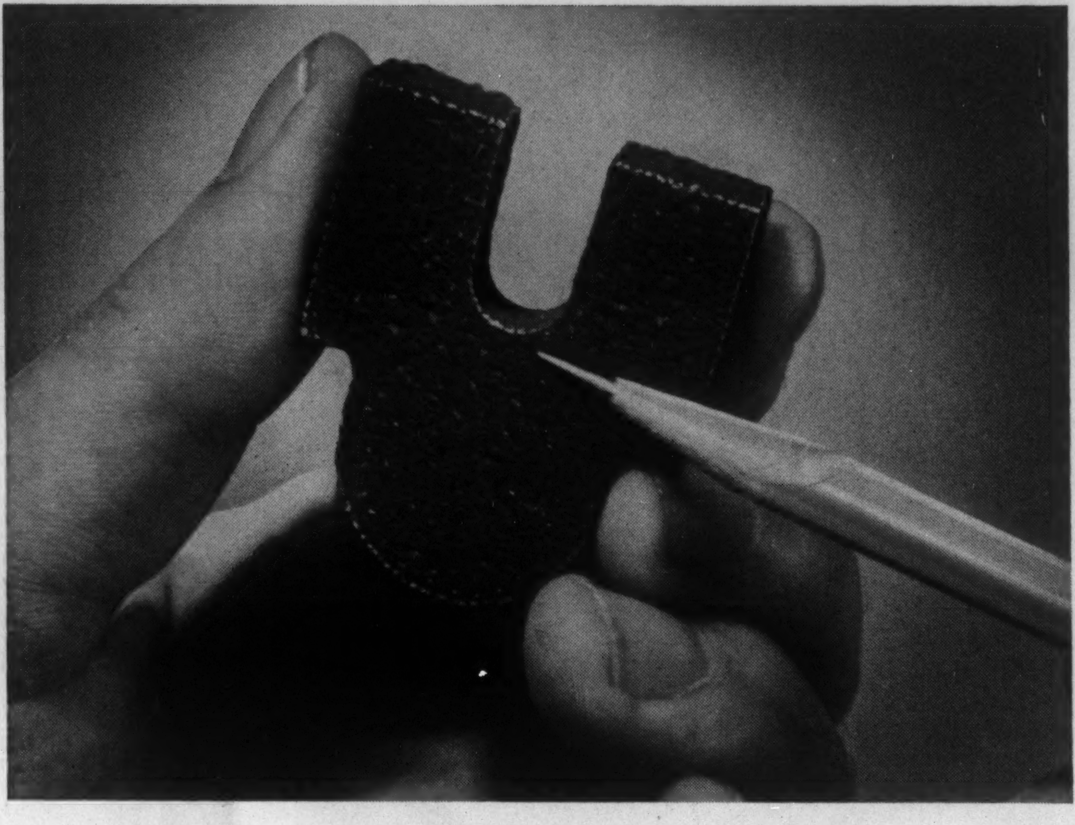
Skid rails are used to support the work being heated and to protect the bottoms of furnaces from abrasion. These rails can be made of water-cooled pipes or of uncooled heat resisting alloys. Both materials have certain disadvantages. With the former, cold spots may appear on the work. With the latter, the material being heated can weld momentarily to the alloy skid and tear loose, leaving a blemish on the bottom. Alloy skid rails also warp in service and considerable maintenance is necessary to keep the furnace operating satisfactorily. Silicon carbide brick or tile have been substituted for both types of skid rails. In most installations, the first cost of the silicon carbide rails is lower than that of the alloy rails replaced and, in addition, the service life is longer. In the steel industry, silicon carbide skid rails have replaced alloys and water-cooled pipes in many furnaces used for sheet, bar, plate, and billet heating, pipe annealing and heat treating. The elimination of the troubles always associated



Arrow points to silicon carbide skid rails supporting brass billets. In this furnace, the alloy skid rails formerly used required replacement every five weeks. The silicon carbide skid rails were in service for three years.

with water cooling is a most valuable feature here.

The wear resistance of silicon carbide refractories leads also to applications in systems for the handling of abrasive materials. In a cyclone for the collection of a particularly abrasive dust, for example, a hard-burned fire brick lining lasted a month while a silicon carbide lining is still in service after 30 months. Another application involves pneumatic systems, which are used frequently for the conveying of solid particles. Abrasion is particularly severe at points where the stream changes direction, as at "tee's" and "ell's". By lining these sections of the pipe with silicon carbide shapes, service life has been materially increased. Silicon carbide impellers for centrifugal pumps handling sand and similar materials in liquid-suspension have given long service under these severely abrasive conditions. Other uses of silicon carbide liners which are related directly to their abrasion resistance are coke chutes, hot-blast mains of blast furnaces, and crossovers in water gas generators.



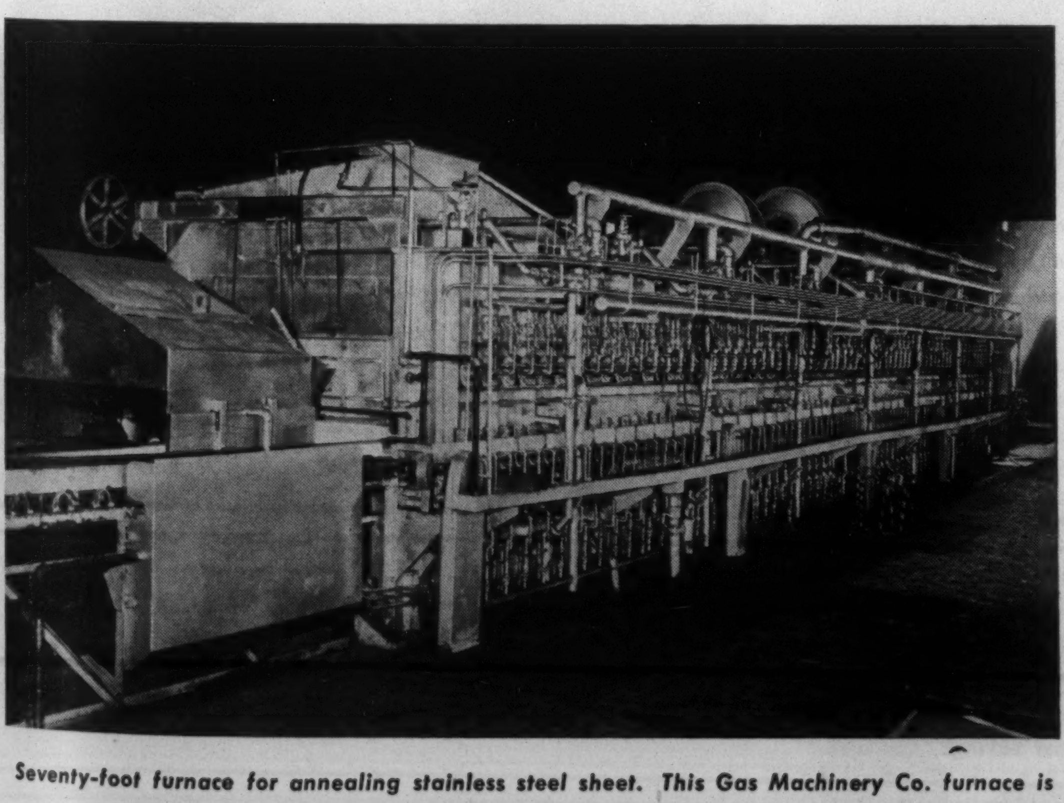
Silicon carbide wire guide used in pickling and plating tanks to conduct the wire through the solutions. (Carborundum Co.)

An application of silicon carbide shapes for moving parts is illustrated by the use of this material in roller hearth furnaces for handling sheet and similar products. Many of these furnaces are equipped with water-cooled rollers. With this arrangement the roll surface, being much cooler than the furnace, can produce black spots on the sheets. Other furnaces are equipped with air-cooled alloy steel rolls. These may weld momentarily to the sheet, causing surface blemishes, while warping of the rolls can result in unequal annealing.

To overcome these sources of defects, mills frequently resort to rider sheets to carry the work through the furnace and preserve the finish. A number of mills have replaced metal rollers of both types with silicon carbide jacketed rollers. These consist of a water-cooled steel shaft covered with an insulating material outside of which the silicon carbide roller is mounted. They have a number of advantages. Since the surface temperature of the rollers approaches that of the furnace, because of the layer of insulating material, black spots do not occur and they do not weld to the sheet. Thus, it is not necessary to use rider sheets to protect the finish of the work. It is possible to maintain full hearth loading at 2000 F, while with alloy rollers hearth loading must be reduced as the higher operating temperatures are approached. The rolls can be stopped entirely without danger of sagging if soaking periods are required. Since the silicon carbide rollers do not warp, maintenance is reduced.

Uncooled silicon carbide rollers are also in service. These consist of an alloy steel shaft jacketed with a silicon carbide refractory. In furnaces for the annealing of silicon transformer steel, for example, such rollers have replaced alloy steel in a number of installations. In addition to improved performance, the cost of the silicon carbide jacketed rollers, including shaft, is less than that of the alloy rollers replaced.

The applications cited indicate the possibilities of using silicon carbide for service involving resistance to heat, abrasion or corrosion. Other uses will occur to those concerned directly with the selection of materials for such purposes. The materials engineer, confronted with a tough problem in this field and a shortage of the corrosion or heat resisting alloy he would normally specify, may find a suitable alternate in silicon carbide.



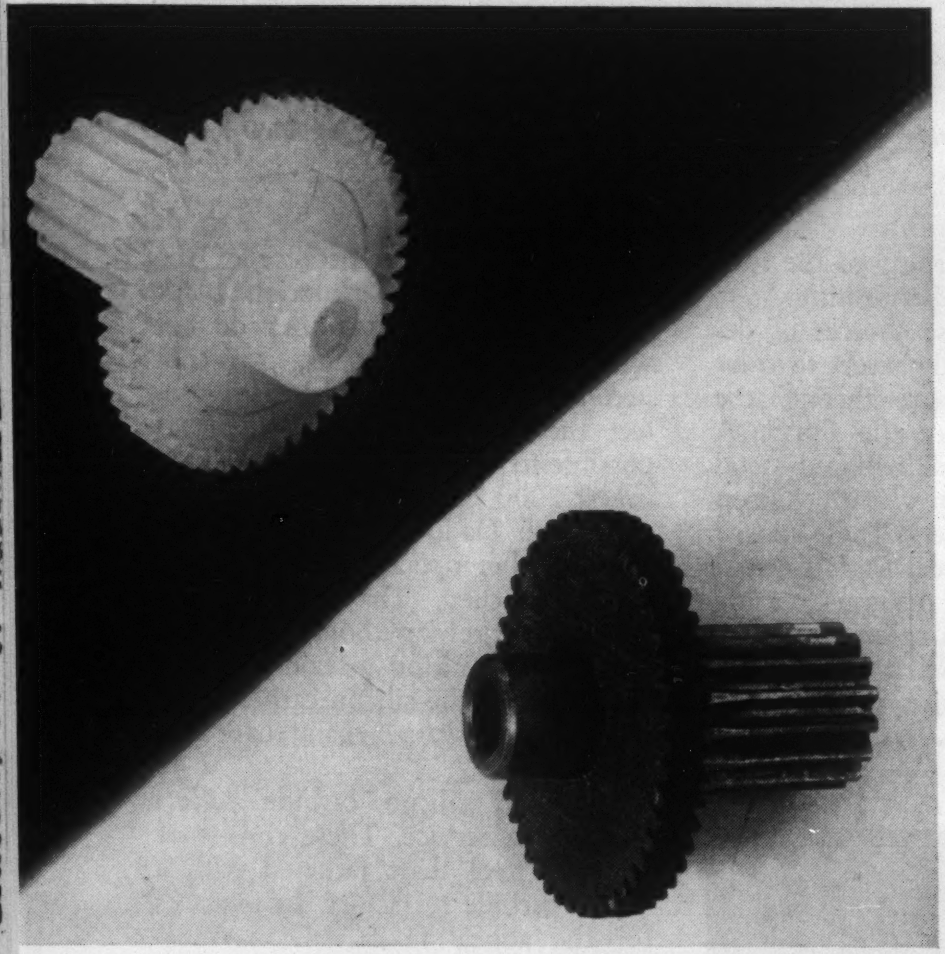
Seventy-foot furnace for annealing stainless steel sheet. This Gas Machinery Co. furnace is equipped with silicon carbide radiant heat tubes and silicon carbide rollers.

Materials at Work

Here is materials engineering in action . . .

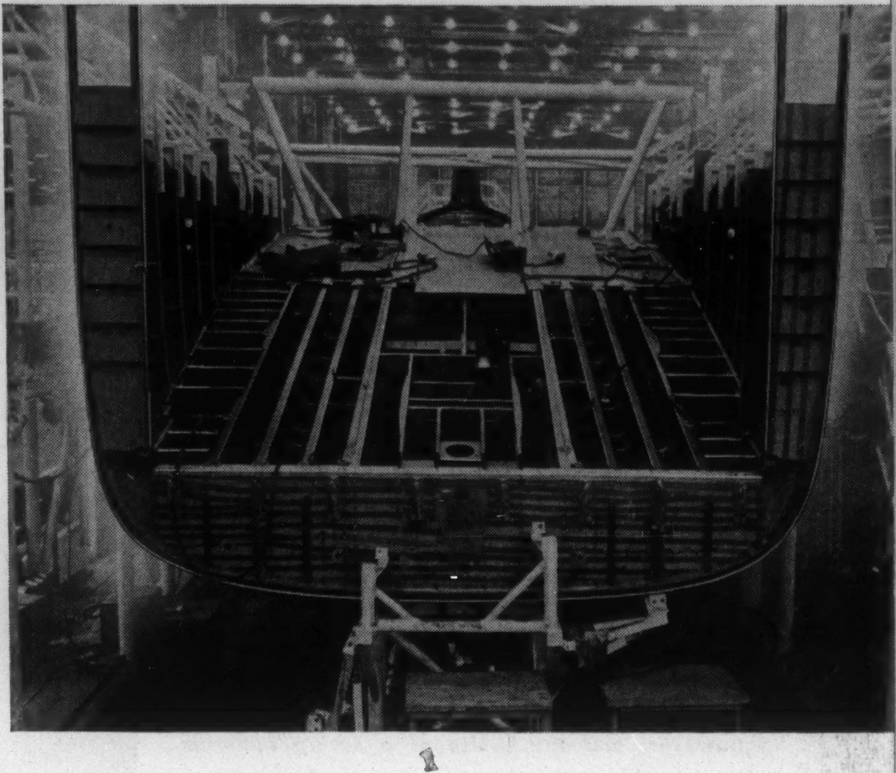
New materials in their intended uses . . .

Older, basic materials in new applications . . .



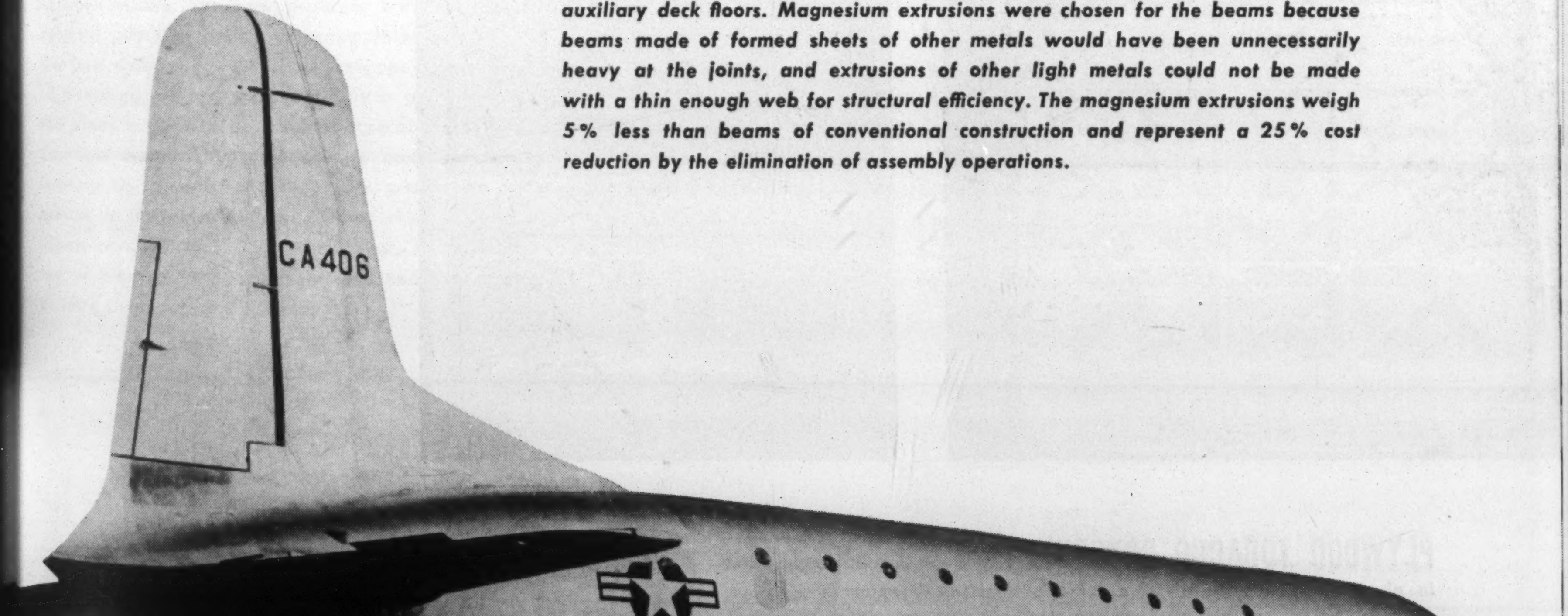
NYLON FAN GEARS *Cost savings averaging 63% have been obtained on gears for the G-E oscillating fan by replacing three metal gears with molded nylon gears produced by the Taunton, Mass., molding plant of General Electric's Plastics Dept. Rotating at a speed of 32 rpm with a maximum torque of 6.75-oz inches, a molded nylon worm wheel and pinion alone permit cost savings of 65%, as compared with the original construction of a steel pinion and laminated plastics gear, where hobbing, cutting and assembly operations were required. Molded in a Fellows-Leominster injection press specially designed for economical nylon molding, no machining operations are required on the nylon wheel and pinion. Assembly operations are also eliminated since the two parts are molded as one unit. Tests show that the nylon gears now used in two models of the G-E fan have excellent wear characteristics as compared with the previously used steel and laminated gears. Quieter operation, in addition to substantial cost savings, has also been obtained.*

PLASTICS IN RADIO COMBINATION *Radios and record player manufacturers tailor their products to catch the eye. This Zenith combination is an example of the appearance advantages derived from Durez phenolic compounds. Eye-appeal here depends on the smooth contours and the rich glossy finishes obtained with a phenolic cover and cabinet. There are other advantages besides looks, however. The phenolic plastic is self-insulating and non-resonant. It is not affected by spilled liquids, either, and can be cleaned quickly and easily. The Zenith model is molded of brown mottled Durez by the Chicago Molded Products Corp. Vents and the front opening for the dial mechanism are already in the parts when they come from the mold. The whole unit is 9 in. high with the cover closed, and measures 16 by 19 in.*

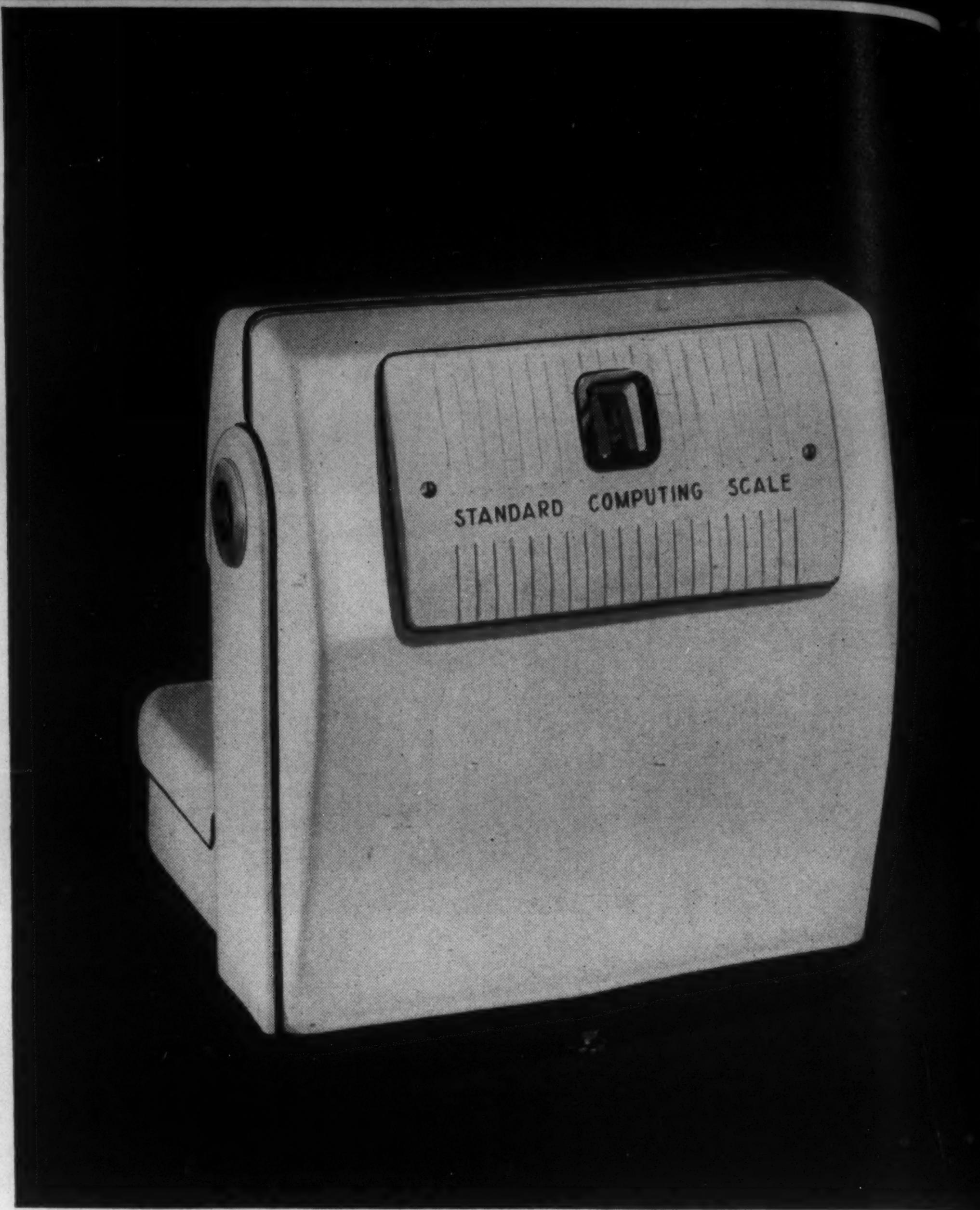


MAGNESIUM IN THE DOUGLAS GLOBEMASTER II

The Douglas C-124 Globemaster 11 is the largest American Air Force transport plane. More than 3500 lb of magnesium is used in the structure of every Globemaster, and a considerable amount of the light metal is incorporated into the government-furnished wheels, engines, electronic equipment and instruments. Magnesium is used so extensively mainly to keep the plane weight down and the pay load high, of course. The light magnesium second deck folds back to carry troops, and the deck itself comes in sections so that different combinations of troops and cargo can be carried. The principal C-124 assemblies using magnesium are the I and H deck beams and the corrugations on the underside of the auxiliary deck floors. Magnesium extrusions were chosen for the beams because beams made of formed sheets of other metals would have been unnecessarily heavy at the joints, and extrusions of other light metals could not be made with a thin enough web for structural efficiency. The magnesium extrusions weigh 5% less than beams of conventional construction and represent a 25% cost reduction by the elimination of assembly operations.

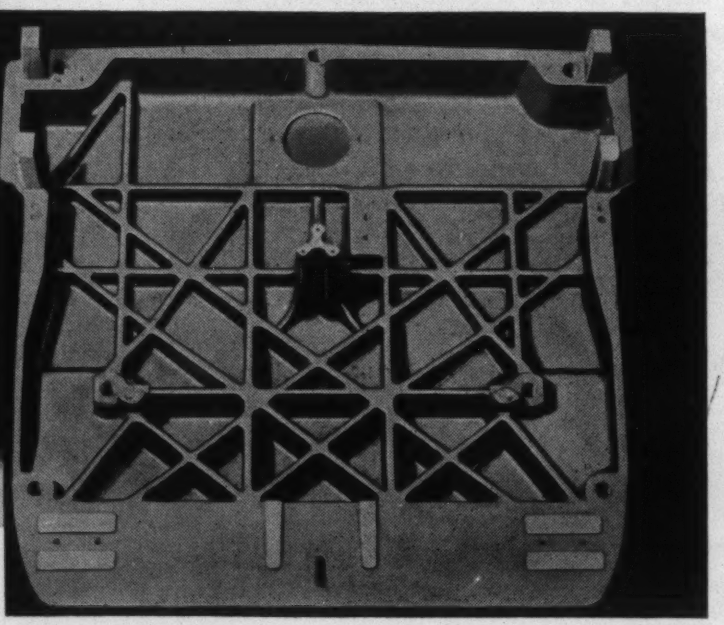


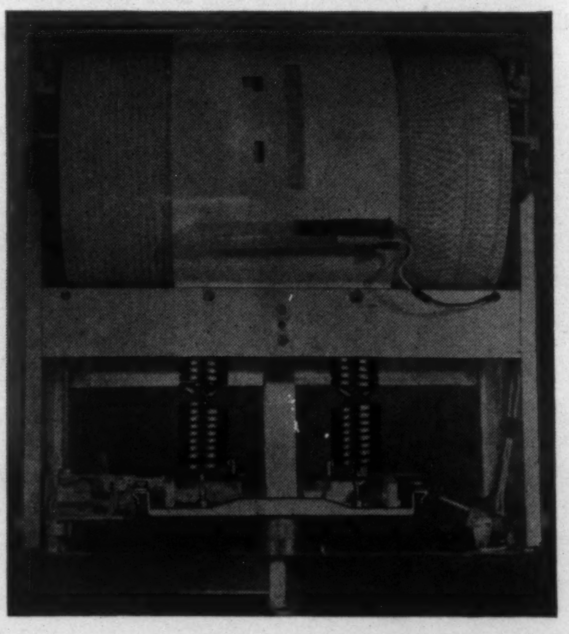
Materials at Work



COMPUTING SCALE

In the design of the new computing scales of the Standard Computing Scale Div. of the U. S. Slicing Machine Co., materials selection was an important item. An acid-resisting porcelain finish was chosen to make cleaning easy and keep the machine attractive to customers in retail stores. The accuracy of the scale demanded jeweled bearings. With frequent cleaning, rust would be a problem in a scale of this kind, so aluminum, rib-reinforced for light-weight strength, was selected for the base. The main requirement in the scale was accuracy, however, and the choice of a spring material that would retain its accuracy over a long period of time under varying temperatures was a big problem. Iso-Elastic, a spring alloy patented by John Chatillon & Sons of New York, was found to be practically independent of temperature changes and performed within the accuracy required by law over the whole range of possible temperatures.



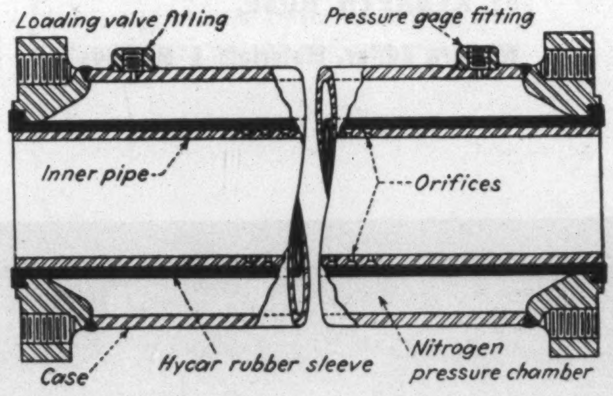


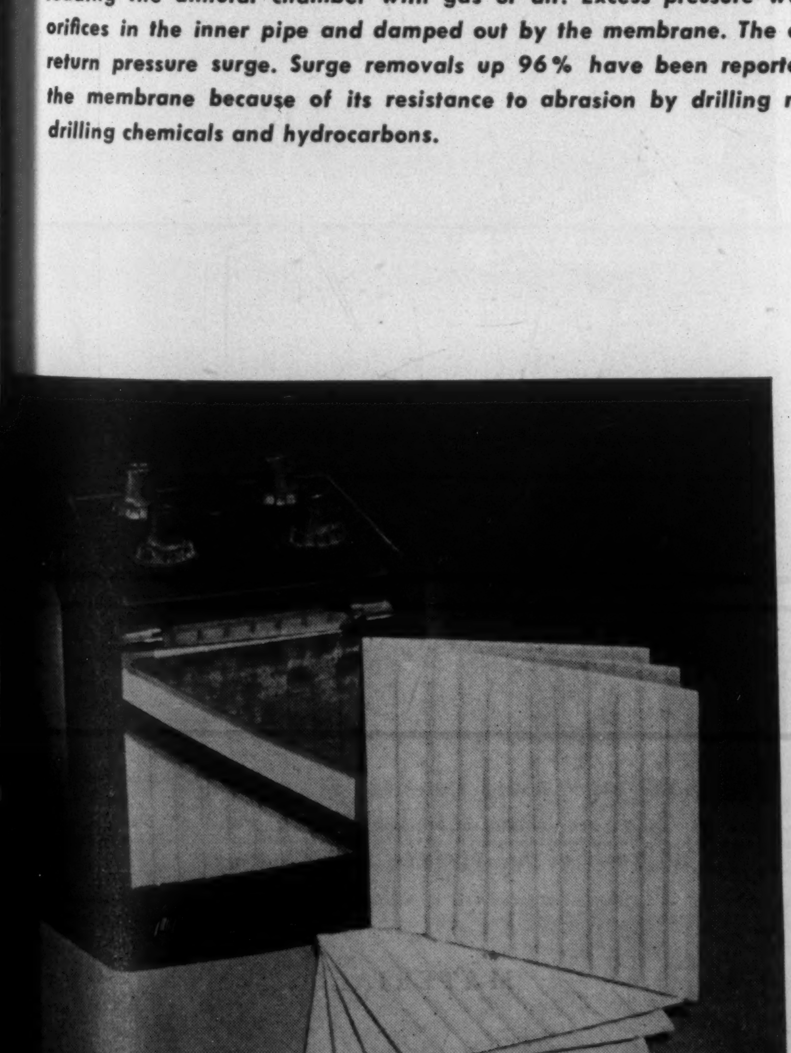
PLYWOOD TOBACCO ORDERING BOX

Of vital importance in plywood's many industrial applications is its resistance to moisture, heat, freezing and other extreme conditions. In the tobacco leaf ordering box in the Leaf Div. of Larus & Brothers Co., Inc., Richmond, Va., plywood is continually exposed to steam heat of 212 F and relative humidity of 95%. Double-wall construction of Douglas fir plywood, specs ½-in. EXT, grade A-A, painted with Dupont Res-Talic heat resistant paint, is used successfully. The discharge end of the machine and the vent hood for excess steam are shown in the foreground. Five steam inlets can be seen along the bottom of the box, and a fan motor is on top of the box, just left of center.

RUBBER VALVE MEMBRANE

Damaging pulsations and shock in oil pipe lines are virtually eliminated by the use of the Fluidynamic Desurger, made by the Valve Engineering & Development Co. When a valve is closed on a moving liquid, hydraulic shock or water hammer results. The new desurger handles the excess pressures from valve shock as well as from pumping action. It accumulates the pressure waves and discharges them back into the line without lowering the average pressure. This unit consists of a pipe with a series of throttling orifices, surrounded by a second pipe of larger diameter. The chamber between the pipes is divided by a membrane of Hycar rubber, made by the B. F. Goodrich Chemical Co. This membrane, or sleeve, is balanced with respect to the normal line pressure by loading the annular chamber with gas or air. Excess pressure waves are throttled by the orifices in the inner pipe and damped out by the membrane. The orifices also damp out the return pressure surge. Surge removals up 96% have been reported. Hycar was chosen for the membrane because of its resistance to abrasion by drilling mud and deterioration by drilling chemicals and hydrocarbons.





FIBER GLASS BATTERY SEPARATOR

One unit performs the functions of a separator and a retainer mat in storage batteries equipped with this fiber glass battery separator. Separators are thin, ribbed sheets, inserted between the plates to prevent short circuits. Fiber glass separators stand between rubber and wood in price and are claimed to equal rubber in performance. They are not brittle and can be handled easily; since they are dimensionally stable, they will not warp or buckle in the battery. The fiber glass separators can be stored without deteriorating, and they are not harmed by moisture. Fiber glass, of course, will also resist high gravity battery acid.

De-Enameling Process Economically Reclaims Defective Enameled Ware

By stripping off imperfect vitreous finishes in a strong alkali bath, shaped iron and steel pieces can be salvaged for refinishing with consequent savings in cost and scrap.

by KENNETH ROSE,
Western Editor, Materials & Methods

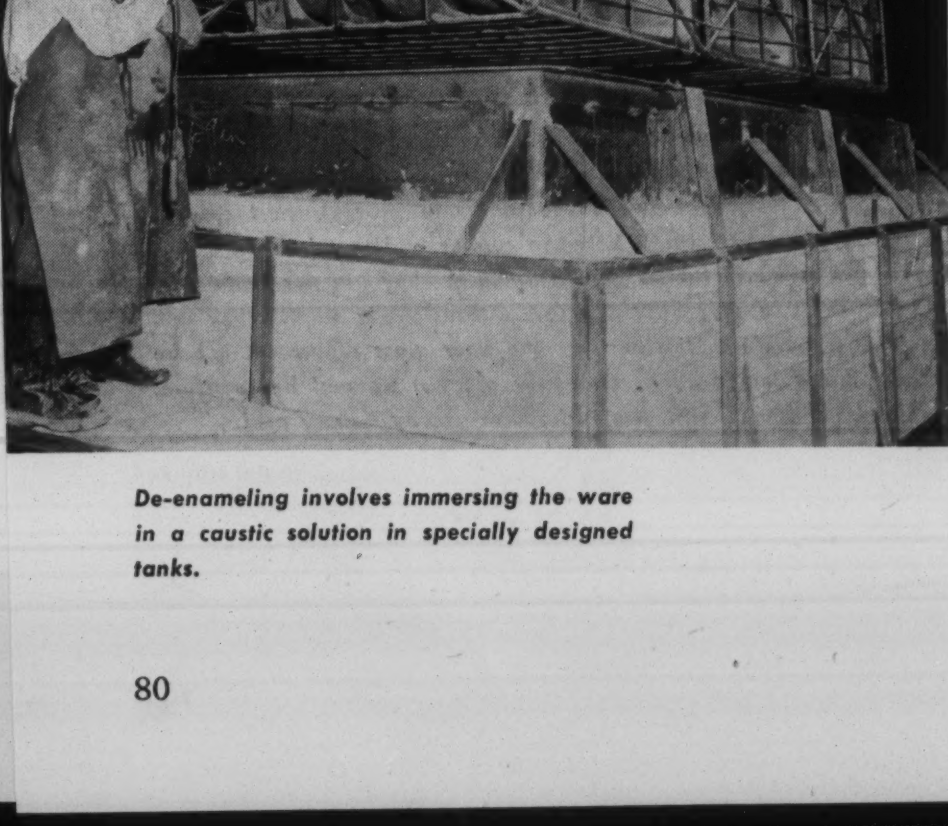
● WHEN FINISHING ironware with a coating of vitreous enamel, the difficulty of reclaiming defective pieces by removing the coating and refinishing is much more difficult than with most other surface finishes. Minor defects in the coating can be repaired by removing a small area of the enamel and applying and firing the coating to that area, or by refiring with or without a light spray of frit over the defective area. When extensive defects are present in the coating, the piece can be de-enameled by dissolving the vitreous finish in a strong alkali bath. This saves the iron base. Where the cost of de-enameling is too high to permit economical removal of the finish for recoating, the entire piece must be scrapped.

Recently New Process D-Enameling Corp. began full-scale operations in Aurora, Ill., to salvage some of these pieces for the fabricator not equipped to remove a defective coating. The advantage of such a commercial plant over performing the de-enameling operation in an enameling plant lies in the volume of work that is available. Operation of a de-enameling process for only a few hours a week, as might be required by a single enameling plant, is costly, whereas a commercial plant taking the defective pieces from many enamelers can be operated full time. Refinements in the process and the present high cost of steel have helped to make the operation successful economically.

The Process

The de-enameling process consists of stripping the enamel in a hot caustic soda solution, rinsing, and cleaning the metal surface mechanically by sandblasting. Handling of the pieces is facilitated by conveyors that move the work through the rinsing units and the sandblast rooms.

For the first operation, the pieces are lowered by crane into the stripping tanks, where strong caustic soda solution is held at a temperature of about 300 F by gas burners. There are five stripping tanks, each of 4500-gal capacity, made of ½-in. steel plate. Caustic solution is held in separate storage tanks, and is pumped into the



De-enameling involves immersing the ware in a caustic solution in specially designed tanks.

When parts are removed from the caustic solution they are thoroughly washed to remove all traces of the solution.

stripping tanks as required. Small pieces, or nested pieces of larger size, are placed in a steel basket, the basket is lowered into the tank by a 3-ton crane, and is removed in the same way at the end of the stripping operation. The length of time required for stripping the vitreous coating from the steel will depend upon the thickness of the coating, but is of the order of 30 min to 1 hr.

After the enamel has been dissolved by the caustic solution, the work is raised from the strip tanks and placed on a slot conveyor 6 ft wide and 54 ft long, which moves under spray nozzles. The spray rinse delivers 6000 gal of water per hr to wash away any remaining caustic soda solution as the work moves through the spray booth. The conveyor then continues into the dryer, where the clean metal is quickly dried to prevent any formation of rust.

The final operation consists of a sandblast cleaning and preparation of the metal surface. Here the metal base is blasted to remove any remaining traces of enamel, but the blasting also provides a desirable matte surface on the metal to assist in re-enameling. Pieces are moved into the sandblast room on a gear-driven rubber belt conveyor. After blasting, the pieces move onto a finish conveyor and are carried to the shipping location. Total time required for the complete de-enameling operation is about 3 hr.

The metal bases are returned to the enameler ready to go into the production line as formed metal. Most enamelers have a pickling operation preliminary to applying the enamel. This includes not only a cleaning and acid treatment of the base metal, but occasionally the application of a flash plate of nickel after the chemical treatment. The pickling and subsequent treatments are repeated with the salvaged metal bases, and they are then re-enameled.

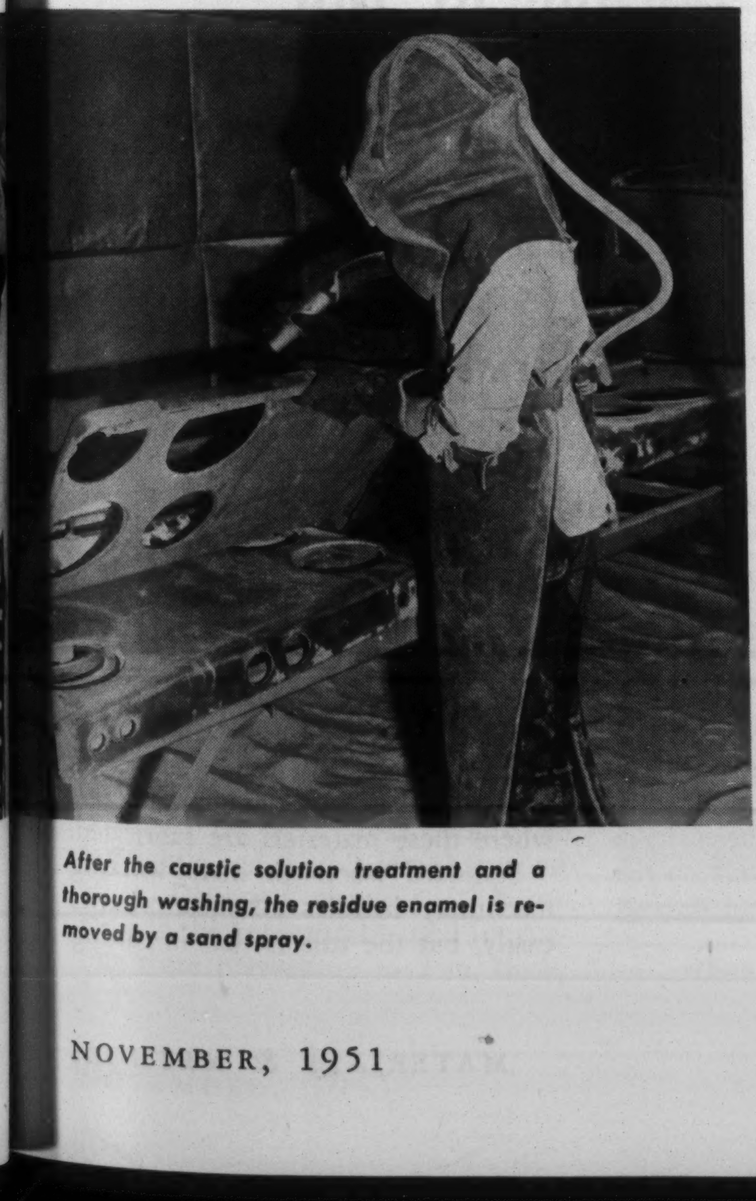
Savings in Cost

This method of de-enameling represents a considerable saving in costs over sending the metal to the steel mills as scrap. The exact cost of de-enameling a piece is difficult to arrive at on a theoretical basis, but the process has been making it possible for manufacutrers to have defective coatings removed and the metal returned for recoating for much less than the cost of new formed base metal.

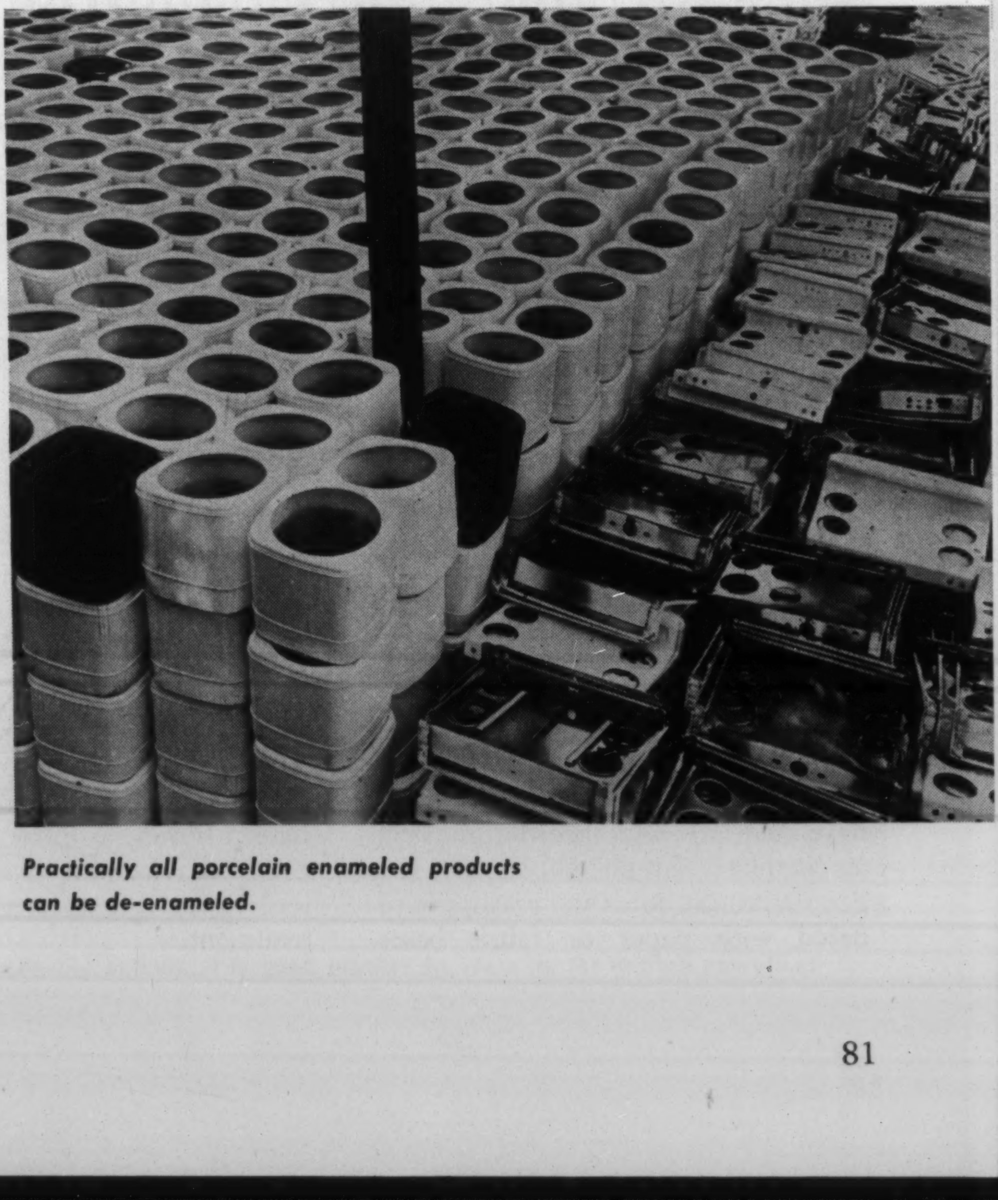
An essential condition to economical operation of a de-enameling plant is volume of production. A pilot plant for commercial de-enameling was operated for two years by New Process D-Enameling Corp. before it began operations in the present plant. The Aurora plant, with a capacity about four times that of the pilot plant, will process about 300 tons of enameled pieces per day, the exact amount depending upon the type of part being processed. When the present plant began operations it had about 100 carloads of defective enameled ware on hand, and many large manufacturers had become clients.

A stove manufacturer reports that of 6200 enameled stove tops that were de-enameled, 6020 were re-enameled and put into salable condition, a recovery of 97%. An appliance manufacturer estimated that salvaging of parts by de-enameling held out the possibility of saving about 75,000 tons of steel in his plant alone.

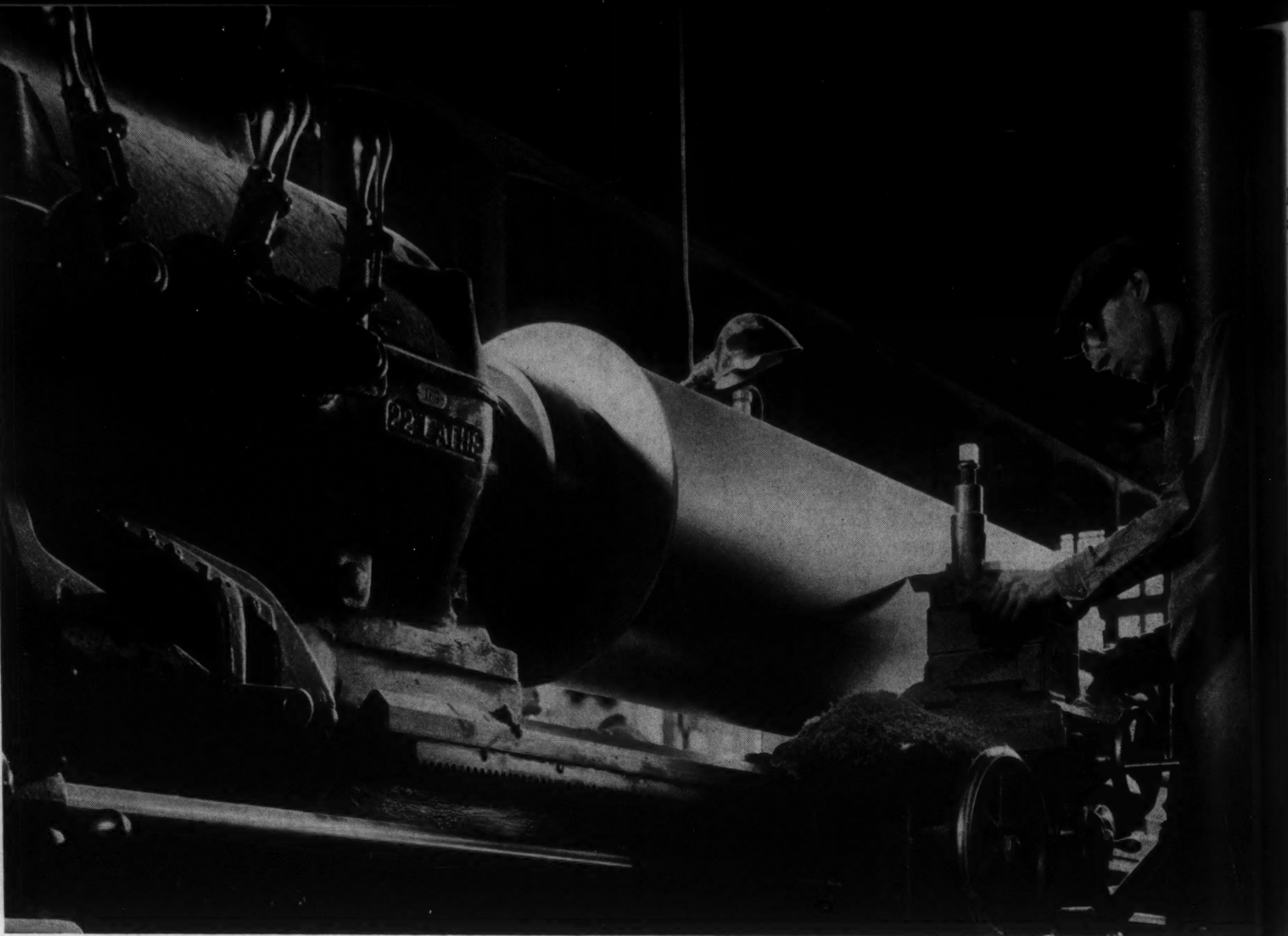
The process is suitable for de-enameling all kinds of enameled ware, such as range tops, sinks, bath tubs, washing machine tubs, signs, and small appliances. At present it is economically suitable for salvage of defective pieces from manufacturers only, where the de-enameled piece can be returned to production. Old enameled ware that is to be scrapped is melted down without de-enameling and old pieces that might be reclaimed on an individual basis usually do not warrant the cost of the process.



After the caustic solution treatment and a thorough washing, the residue enamel is removed by a sand spray.



Practically all porcelain enameled products can be de-enameled.



Standard wood- or metal-working equipment is suitable for machining asbestos, glass and graphite grades of plastic laminates.

How to Machine Laminated Plastics of the Asbestos, Glass and Graphite Grades

by LEWIS C. ROWLAND, Synthane Corp.

The recommended practices given here for machining, sawing, shearing and punching, drilling and broaching should prove helpful to all those fabricating these grades of laminated plastics.

● EASY MACHINABILITY IS one of the distinguishing characteristics which have led to widespread industrial acceptance of laminated plastics. This generalization holds for plastics laminated with paper or fabric bases. Those with asbestos or glass fillers, or those which are graphite-impregnated, however, differ sufficiently in their behavior and their effect on the tool to call for different and distinct treatment.

These grades are steadily coming into increasing use because of their flame and arc resistance, higher mechanical strength, increased moisture resistance, and — in the case of the graphited grades — their anti-friction properties. Accordingly, a review of recommended machining practices will prove helpful in industrial plants where these materials are fabricated.

Standard wood- or metal-working machinery handles all these plactics easily, but the rule is that in cutting laminated plastics, the tool must always have greater clearance than is used for metals. Because feeds are faster with the plastics, this extra clearance is necessary to prevent the heel of the tool from dragging against the work and impeding the succeeding cut. Also, tool rake usually should be slight, and in some cases even negative.

Machining

When machining abestos and glass-filled or graphite-impregnated laminates, tool speed should be reduced and feed increased where experience indicates the work will stand it. This method gives the effect of breaking the fibers, rather than shaving them. Speed is lowered in order to reduce the heat which may be developed rapidly in machining these special grades, and in order to reduce tool wear. One case where this is desirable is the use of single-point tools, such as fly-cutters. This tool, however, needs more speed than does a multiple-tooth cutter, so as not to take too heavy a cut.

Of the three types of materials under discussion, glass-filled laminates, in particular, require slow speeds. Use of a coolant is desirable but not necessary. Lathe work, where it is difficult to apply a coolant, can be handled satisfactorily if speeds are kept down to approximately 200 surface ft per min.

In one shop which was turning disks of glass-filled laminates, for example, carbide-tipped tools were being spoiled in the first few inches of tool travel. When the problem was submitted to Synthane Corp., in whose plant glass-filled laminated components are fabricated daily, the trouble was diagnosed quickly as excessive machine speed. The graphited grades require tool speeds nearly as moderate as those used for glass. On lathe work, use of a carbide-tipped tool is standard practice.

Sawing

Sawing these materials is best accomplished using a diamond-tipped saw which is adequately cooled, preferably by water in ample quantity. Where possible, use of a band saw should be avoided because the blade cannot be cooled. If a band saw must be used, work should be fed lightly and the blade resharpened often. Diamond wheels 1/16 in. or more in thickness can be used for cutting these plastics up to 2 in. thick, and are superior to steel blades for all glass-base and most asbestos-base materials. A flood of water on the work and wheel can be used when necessary to prevent overheating and "loading" of the wheel.

Shearing and Punching

Shearing and punching practices for the three special grades are the standard ones used for the laminated plastics generally, although only the thinner sheets should be punched. Harder stocks can be sheared after heating to from 200 to 250 F, depending on grade and thickness. Heating, by hot plate, oven, hot oil or infra-red lamps, should be uniform, and the material should be removed from the heating medium as soon as it reaches the required temperature.

If the work calls for drilling in these special grades in thicknesses in excess of 1 in., the recommended procedure is to grind the drill off-center in order to enlarge the hole and reduce friction, which lowers the destructive heat. Then, for a true hole and a fine finish, go through with a carbide-bit boring tool.

Drilling

For drilling in flatwork, carbide-tipped drills are recommended for the glass, asbestos and graphited grades. Care must be taken to back up the hole so that the side where the drill comes through will be clean and free from burrs. Wherever the quantity will permit, a drill jig should be used, so designed that the top plate containing the layout can be clamped on the plastic, holding it rigid and tight against the bottom of the jig. Allow the drill to run into this bottom plate. Such a design, has been found, to largely eliminate breaking out at the bottom and lifting at the top. Drill in multiples wherever possible.

When drilling deep holes, back the drill out several times, especially if it is small. The average drill under No. 10 in size will tend to run off if the hole is much deeper than ½ in. Drilling at right angles to laminates

Wherever quantity permits, it is good practice to use a jig for drilling operations.

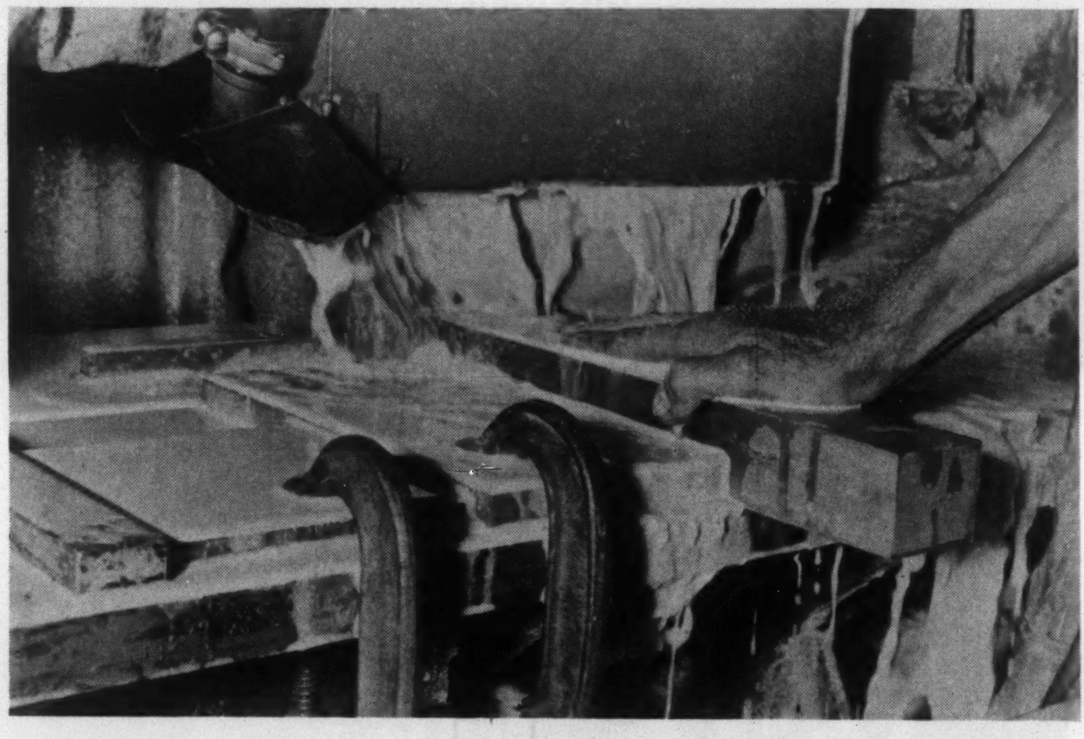
can be done easily with a commercially ground drill. To prevent delaminating when drilling parallel to laminations, increase the included angle of the drill point and clamp the work securely with side pressure in a vise or drill jig. It is important to withdraw the drill several times when drilling parallel with laminations.

Broaching

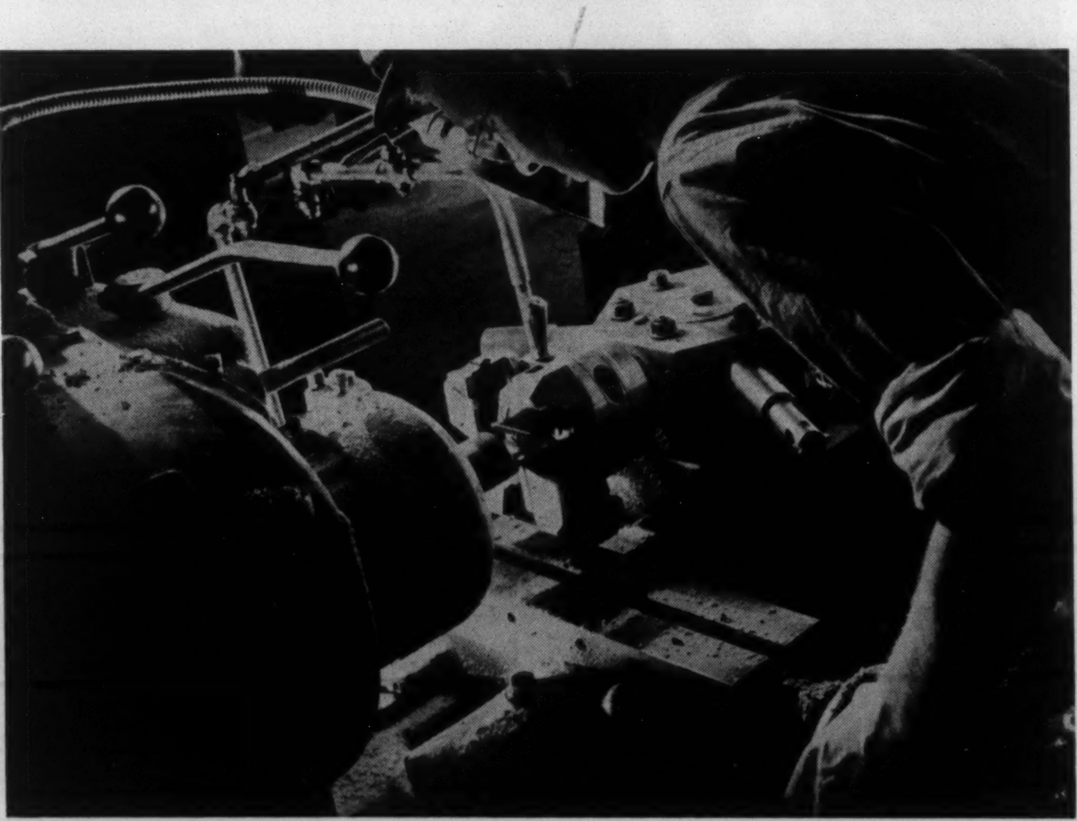
Broaching can be done with hydraulic, motor-operated or hand-operated broaching machines, either vertical or horizontal, or on a standard punch press. Standard broaches with approximately 4-deg cutting clearance and a slight positive rake are used. Except for this clearance angle, the broach is the same as is used for brass.

Broaches will produce square, hexagonal and other polygonal holes, irregular shapes, keyways, etc. However, the laminated structure of the material requires a special broaching procedure. When cutting across the laminations, the material must be backed up with a mild steel or brass plate which forms a slide fit with the last cutting tooth on the broach; this prevents fraying and breaking out of the edges.

When cutting parallel to the laminations, use a fixture to apply pressure at right angles to the laminations. Teeth of the broach should be so spaced that, except for the beginning and end of the cut, at least two teeth will be in contact with the material. Ample chip room between the teeth, based on the depth of cut per tooth, should be provided. Use a tapered pilot pin as large as possible to facilitate rapid operation. And, to prevent the material from splitting out when cutting starts, back it up with flat washers of the same size as the pilot. Depending on the material and the type of operation, a cut of 0.001 to 0.005 in. per tooth can be taken, with the pitch ranging from 1/4 to 3/4 in.



Large cut-off saw used for asbestos- and glass-base grades in the Synthane plant.



Threads can be cut on a lathe, or with taps and dies.

Other Operations

Threads can be cut on a lathe, or with taps and dies. The procedure should follow that used for brass. A small quantity of oil gives a cleaner thread. When threading in a lathe, fine cuts should be taken at higher speeds. Self-opening heads are desirable for quantity production. The proper die head also helps to guarantee a smooth, accurate thread.

Tapping should not be specified closer than a Class 2 fit with 65 to 70% of thread. Additional thread depth would add very little strength while introducing the risk of thread breakage. When tapping in a blind hole, allow a depth of several threads from the bottom of the hole to the first full thread, for clearance. Large holes parallel to laminations should be avoided where subsequent pressure, as from a screw, might damage the piece.

Laminated-molded rod and either molded or rolled quality tubing can be machined efficiently on automatic screw machines at speeds as high as 6,000 rpm and at high rates of feed. Diamond and tungsten carbide turning and boring tools can be used to advantage in these operations. Usually, lubricant is used, but on light work or short runs, it may not be necessary.

Milling operations should be accompanied by flush cooling. Climb rather than conventional milling, is recommended, because it reduces friction and throws chips clear of the work. Most milling cutters are supplied with zero rake, and usually work best at that setting in these special grades of Synthane. The work should be backed up with metal or another piece of Synthane to guard against splitting. In designing a part, avoid stopping a milled slot with square corners. Allow the bottom of the slot to emerge to the surface with the natural contour of the cutter.

MATERIALS & METHODS MANUAL 76

Cold heading and machining are often combined. The Townsend Co. cold heads each of these parts, then machines them to the final contours. The design shapes are impossible to cold head directly and the combination process is cheaper than full machine production.

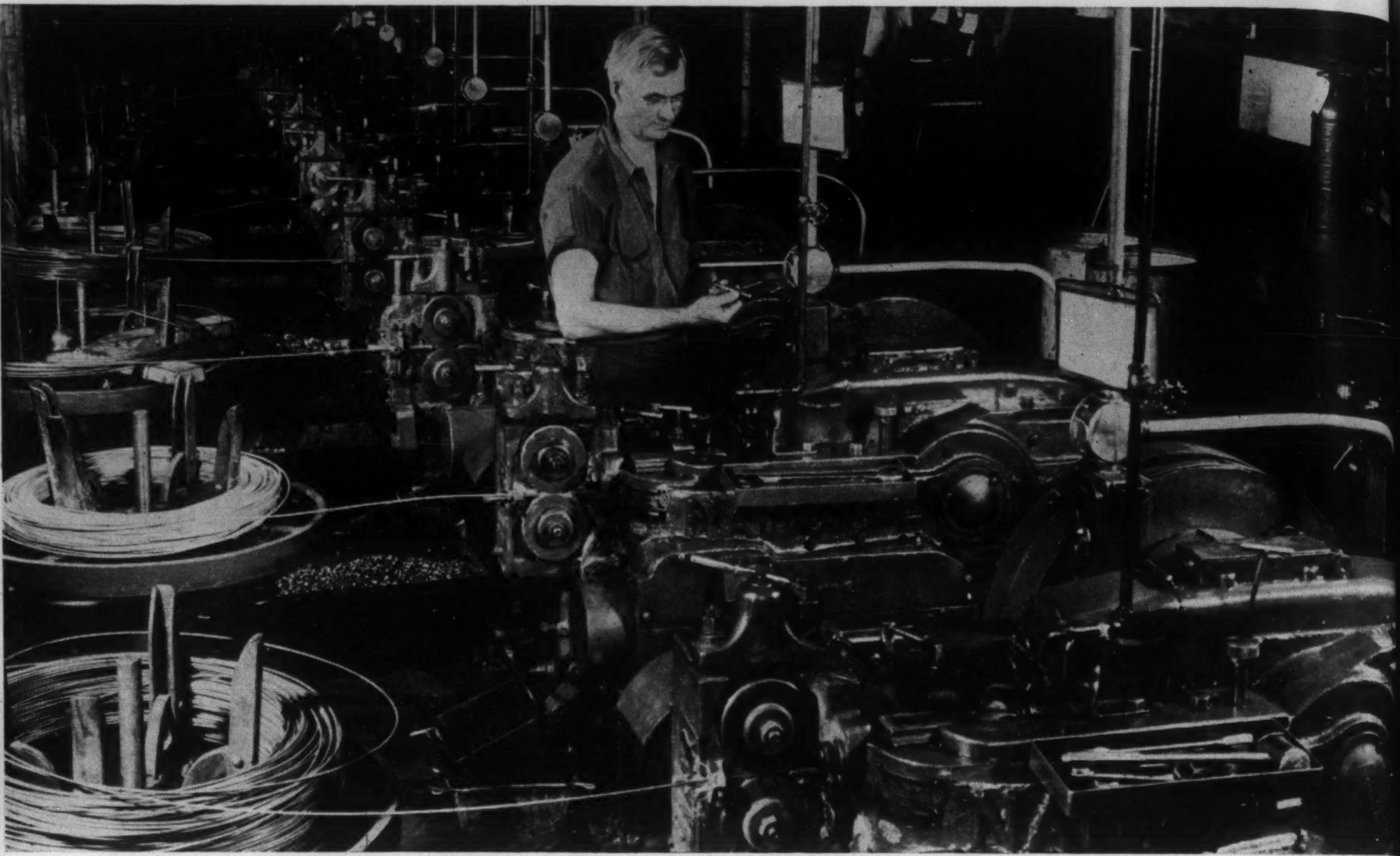
Cold Headed Parts

by Philip O'Keefe, Associate Editor, Materials & Methods

Bolts, screws, rivets, nails, nuts, electrical terminals, anti-friction bearing balls and rollers and other small metal parts are mass produced by cold heading. This is an important process that should be appreciated by materials engineers and designers. This Manual outlines the manufacturing, metallurgical and cost factors you must consider to specify cold heading or to design a cold headed part.

- ***Production Methods and Machines***
- ***Headability of Metals and Alloys***
- ***Design of Cold Headed Parts***
- ***Competitive Place of Cold Heading***

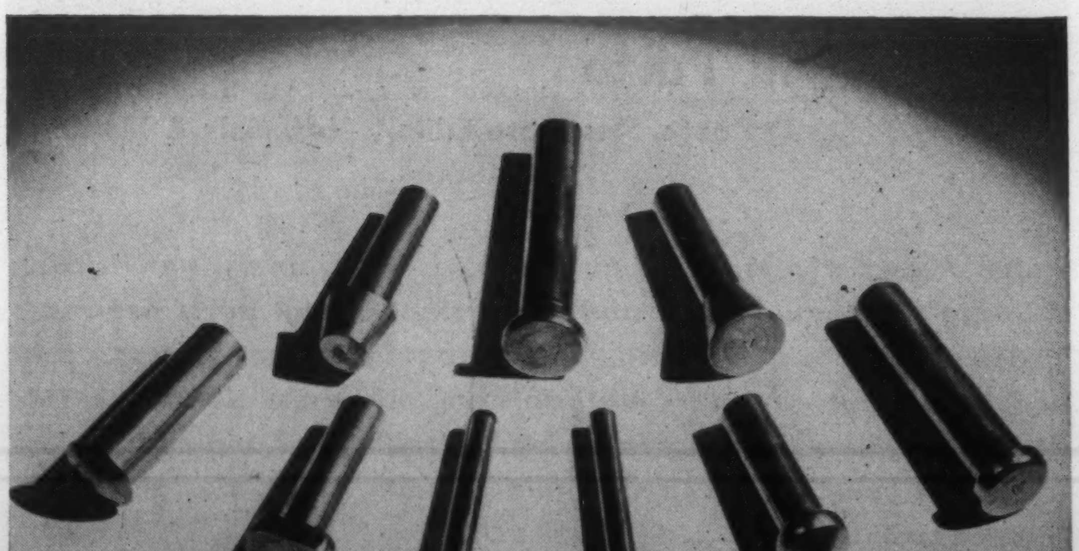
This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application.



Part production at the Townsend Co. plant. Cold headers are high-speed machines, running under the supervision of a header operator. The operator is highly skilled, and success on a difficult part depends largely on his experience and ingenuity.

The designer of any small metal part that is to be mass produced makes a mistake if he does not at least check the possibility of cold heading it. Among other advantages, cold headings have excellent surface finish, good strength and toughness because of favorable grain positioning, and can be produced with a minimum of scrap.

The vast majority of cold headed parts are fasteners—screws, rivets, bolts and nuts. These fasteners are made in astronomical quantities. A single manufacturer will cold head billions of fasteners each year. The often-overlooked fastener manufacturers make up one of the basic American hard goods industries, taking over 2% of our total steel output.

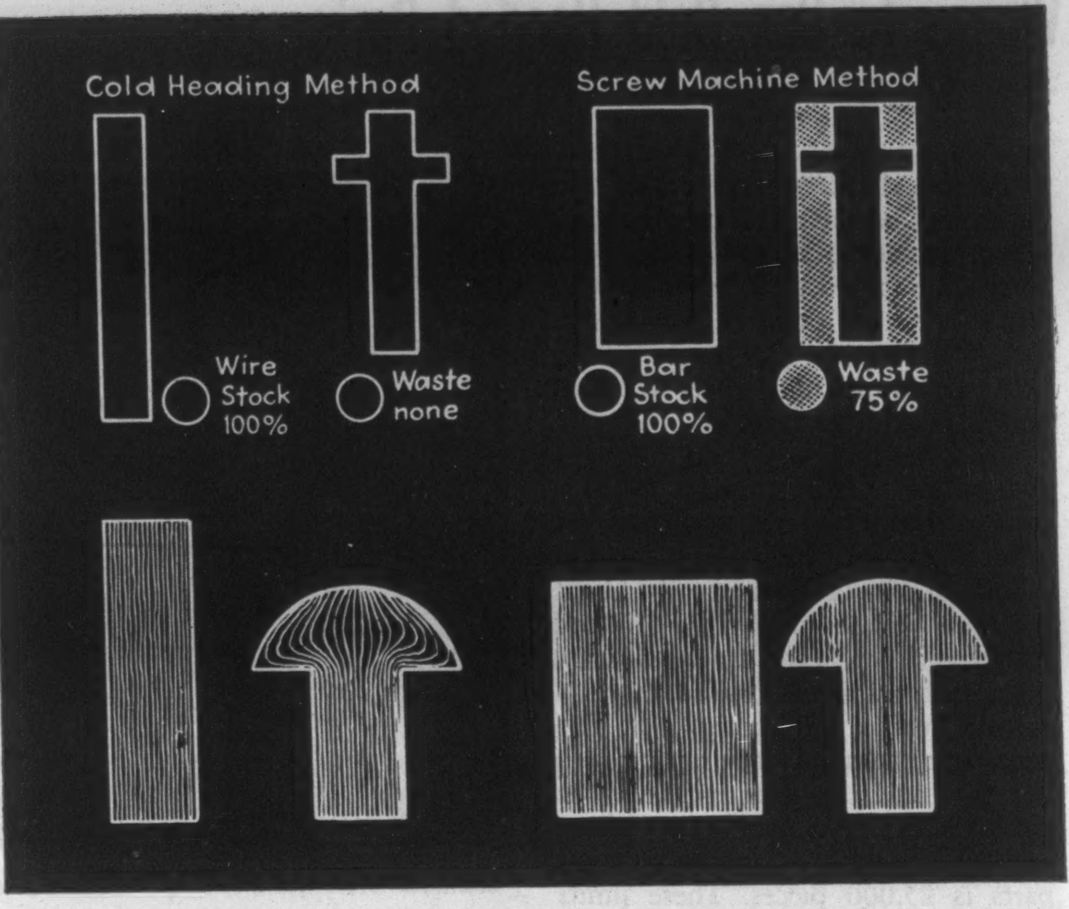


Special rivets and pins are among the cold headed products of the Champion Rivet Co. The surface finish on cold headed parts is superior to that on hot headed products and even most screw machined parts.

While most of this production is in standard fasteners, many special screws, bolts, rivets and nuts are also made. In addition to fasteners, the same companies cold head electrical terminals, capacitor plates, transformer studs, lapel button screws, automobile fuel pump stems, draw pulls, caster studs, ski pole points and business machine parts.

The raw material for cold heading is wire, up to about 1 in. in dia. The wire is held in a die with one end protruding out from the die face. This unsupported end mushrooms out under the force of a punch. The punch motion is roughly analogous to a hammer blow on a chisel. The head is formed between the die and punch faces, or in cavities in these faces. The wire can be held in one die and formed by several punches, or can be transferred to other dies for a series of head-forming operations. The process forms collars in the middle of a part as effectively as it heads a rivet or screw.

The machine used for cold heading, known as a cold header, is



Cold heading saves material on many parts over screw machine methods. A fanned-out grain structure in cold headed parts also increases their strength. (Courtesy John Hassal, Inc.)

This battery of high production machines cold heads nails at the Sparrows Point plant of the Bethlehem Steel Co. The annual production of a manufacturer often runs into the billions of parts.

essentially a punch press laid down on its side. The wire is fed into the machine, where automatic mechanisms cut the blanks to size, position them in the dies, form the heads, and collect the finished parts. The cold header is a complex, solidly constructed machine capable of sustained high-speed operation.

The first axiom of cold headed parts—that they must be mass produced to be economical—is a result of the expensive, complicated, automatic machines used in their manufacture. The cost per unit part of the die, the punch and the setup labor can only be kept low on large production jobs.

The manufacturing costs are not the only factor in the choice of a part, of course, and the peculiar characteristics of cold headed parts must be appreciated. The main advantages of a cold headed part are:

1. The grain of the metal is fanned out to follow the part contours. This favorable grain positioning avoids the surface weaknesses sometimes found in a machined part.
2. Cold heading alloys are tough, ductile and highly resistant to cracking. These are just the qualities desired in most machine parts.
3. The corner fillets required for cold heading increase the fatigue strength of the part.
4. An excellent surface finish is obtained, since the part is cold formed.
5. Cold heading puts all the wire stock into the part. No metal is cut away. The material economy is increased even more by the fact that cold heading wire averages more than 10% cheaper than screw machine stock.

Cold headed parts also have inherent limitations. These include:

1. The shape of the part is limited by the forging operation. The part must be of such a shape that it can be extracted from the die after forming.
2. The head volume and shape that can be upset without annealing are limited.
3. Cold working may leave internal stresses at critical points in the part. However, these can be relieved by annealing.
4. The capacity of present cold headers limits the size of the part.

Making cold headed parts is not a part-time job; with few exceptions, they are produced by fastener manufacturers. Tremendous production facilities and over 100 years of experience are in back of the fastener people. Almost no research data have ever been published on cold heading, and the production methods for new parts must be arrived at by experiment guided by experience.

Because of the empirical nature of die design and machine setup, there is specialization even within the fastener industry. A part that is made successfully by one company will be refused by another. It costs money to find out how to make a difficult part, and the shop which is set up for the part has a jump on any competitor without the same experience. Individual manufacturers have built up special skills with various alloys and part shapes.

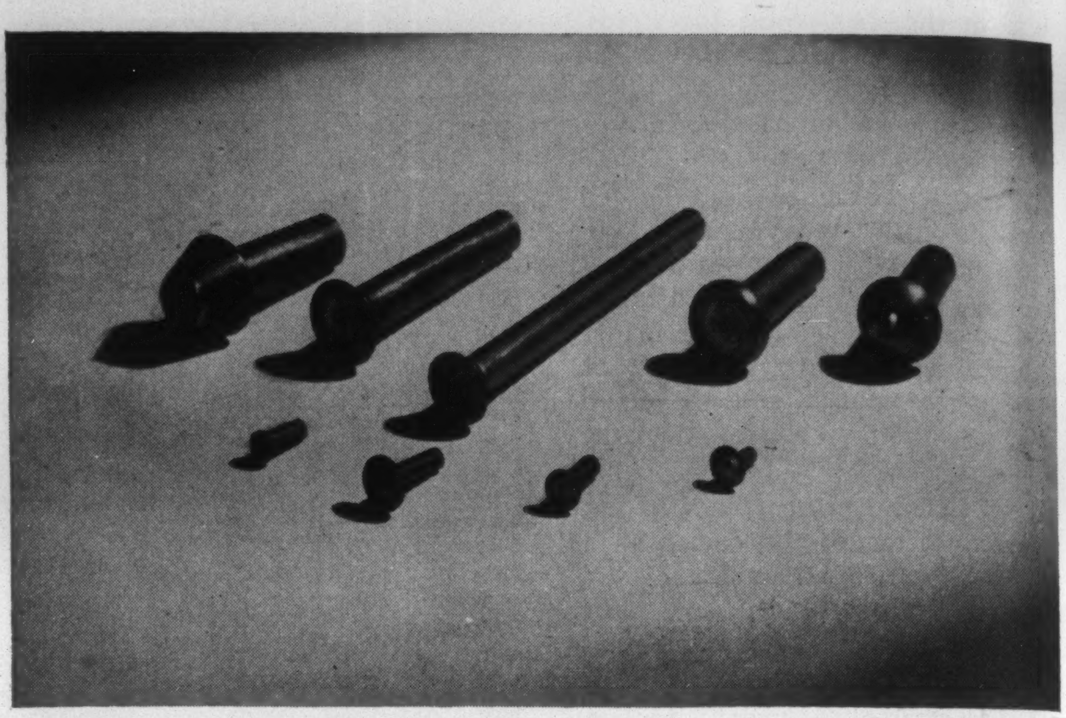
For this reason, any design rules for cold headed parts must be approximate. Exceptions are made to almost every rule. Some parts are, in general, more difficult to make than others, and some alloys are more difficult to cold head than others. Reliable information in any specific case, however, can only be obtained from cold headed part manufacturers.

Where to Use Cold Headed Parts

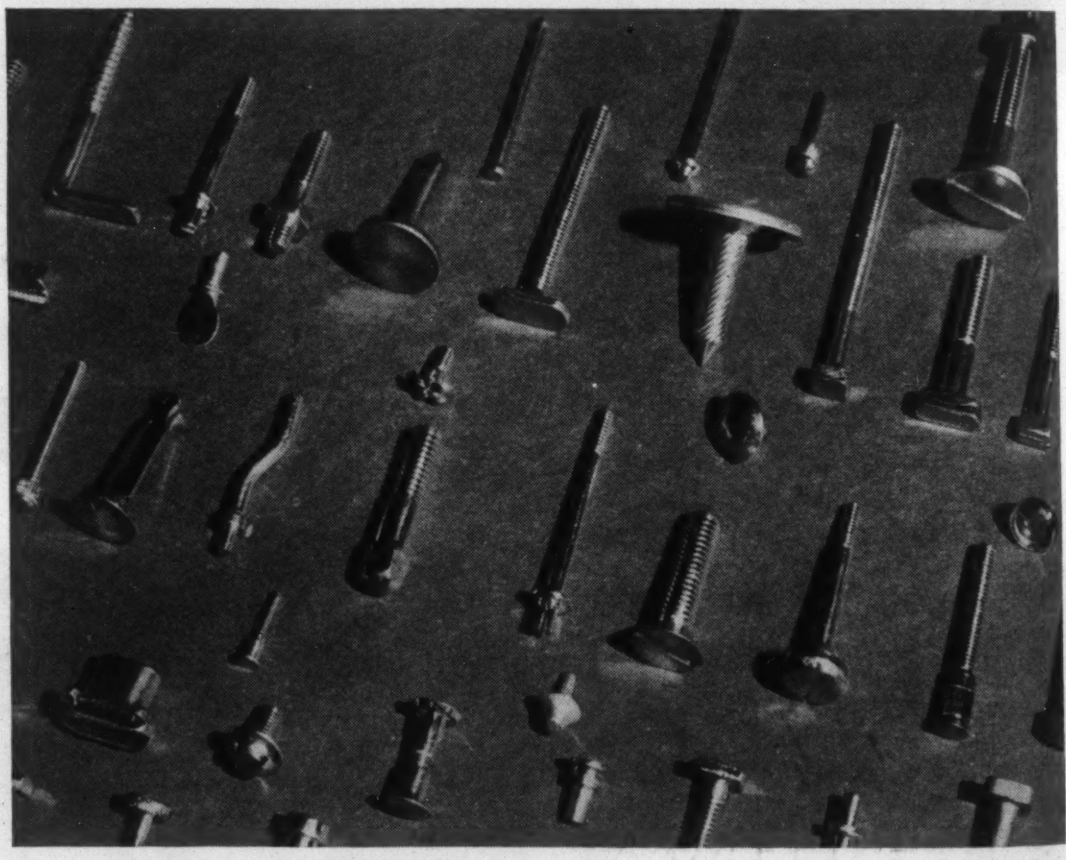
Almost all fasteners 1 in., or less, in shank diameter are cold headed. These include standard nails, pins, screws, bolts and nuts, together with most special or non-standard fasteners. Within this size range, many other small machine parts are also made by cold heading.

Cold heading is by no means a cure-all for small parts. It holds a competitive place because of inherent advantages and limitations. Special cold headed parts are small—about the size of standard cold headed fasteners. The larger the production quantity, the better chance there is to cold head a part successfully. The exact minimum quantity varies with the part and the material, but jobs almost always run over 5,000 pieces and the economic minimum on most parts is 25,000 pieces. These limits hold on simple parts like screws and bolts, while a reasonable minimum order on an oddly shaped machine part is 50,000 units.

The usual competitors to cold heading for any part are screw-machining and hot heading. Hot and cold heading are both developments of the fastener industry, and the competitive balance between the two processes is fairly stable and well defined. The border between cold heading and screw machining is more obscure. The monopoly of cold heading on fasteners is matched by a predominence of screw machining in the non-fastener, small parts field. Many of these special parts should probably be cold headed, and there seems to be a logical field for growth for cold heading here.



Standard rivets are made by the Champion Rivet Co. The tolerances that can be held on cold headed parts on production runs are comparable to the limits on screw machine products.



A variety of parts cold headed by Chase Brass and Copper Co. The number of pieces that can be cold headed economically on one order varies from 5,000 to a quarter of a million. The smaller, simpler and cheaper a part is, the larger number must be ordered.

Cold Heading vs. Hot Heading

Hot heading is a type of hot forging. Wire blanks are cut to size, heated and placed in heading dies by hand for forming. Since the blanks are man handled, fewer operations can usually be performed economically on a hot headed part. A wider range of metals and alloys can be hot headed, however.

Some head shapes that are impractical to cold head can be formed by hot heading. Hex and square heads, hollow and eccentric upsets, and heads not at right angles to the shank are easier to form hot. Piercing and embossing are also easier. At present, hot heading is usually done on 1- to 2-in. wire, although special shapes or difficult materials might be upset hot in wire sizes as small as 3/8 in.

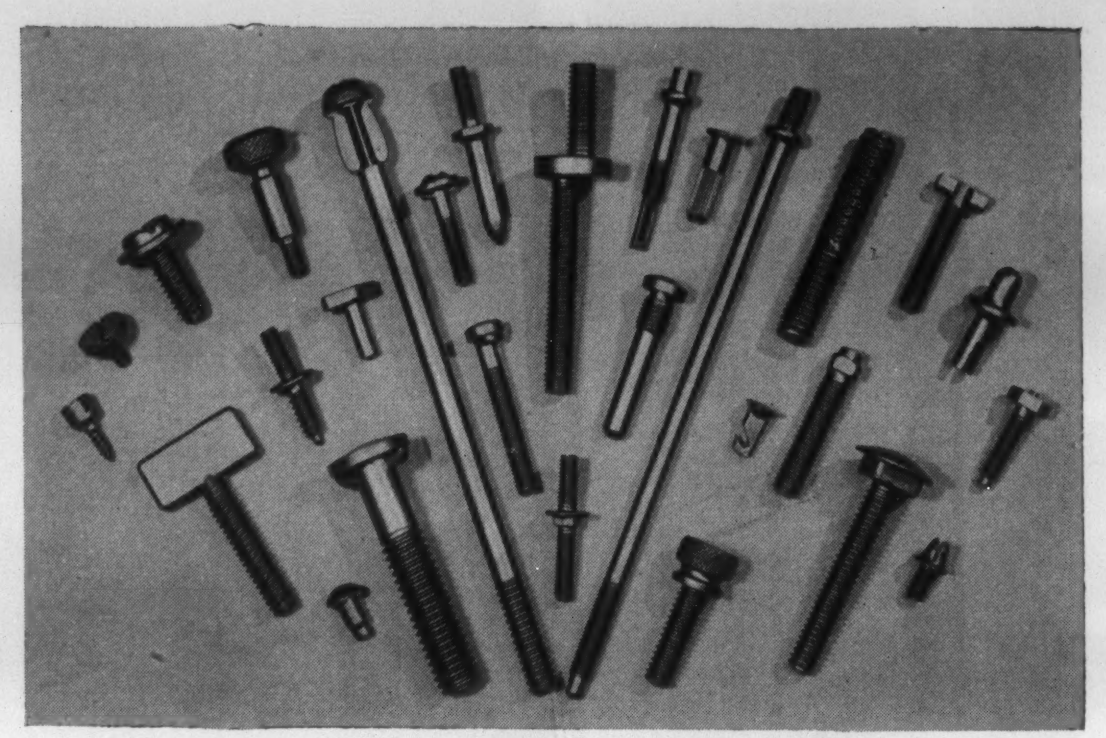
Small quantities are economical in hot heading because parts are handled manually and expensive machine setups are not required for each shape. Runs of 100 pieces or even less are practical in hot heading. On the other hand, labor costs per hot-headed unit are high and production is slow, so that large quantities are not usually hot headed, except in wire sizes too large for cold heading machines. Closer dimensional tolerances can also be held in cold headed parts, and the surface finish produced by cold forming is better.

Cold Heading vs Screw Machining

The part shapes that are made by cold headers and by screw machines are, in general, different. On a screw machine product, the surfaces must be concentric with an axis of revolution, as they are in bushings, round head bolts and machine screws. A cold headed part, formed in a molding rather than a cutting operation, can have eccentric surfaces, but is limited to somewhat simpler contours. While different alloys are used for each process, about the same number of alloys are suited to cold heading as are suitable for screw machining.

Better dimensional tolerances can be held in a screw machine, and larger parts, up to 8 in. in dia, can be made. Sharp corners and more intricate shapes are also easier to make on a screw machine.

The obvious disadvantage of screw machining is the metal wasted in cutting—the whole wire blank is formed into the part in cold heading. This waste is even more serious since screw machine stock is more expensive than cold heading material in the first place. Cold headed parts, besides being stronger due to favorable fiber positioning, are also faster and cheaper to produce on large orders. Even when some machine finishing operations are required, the basic part should often be cold headed, especially when the production quantity is large or the metal is scarce or expensive.

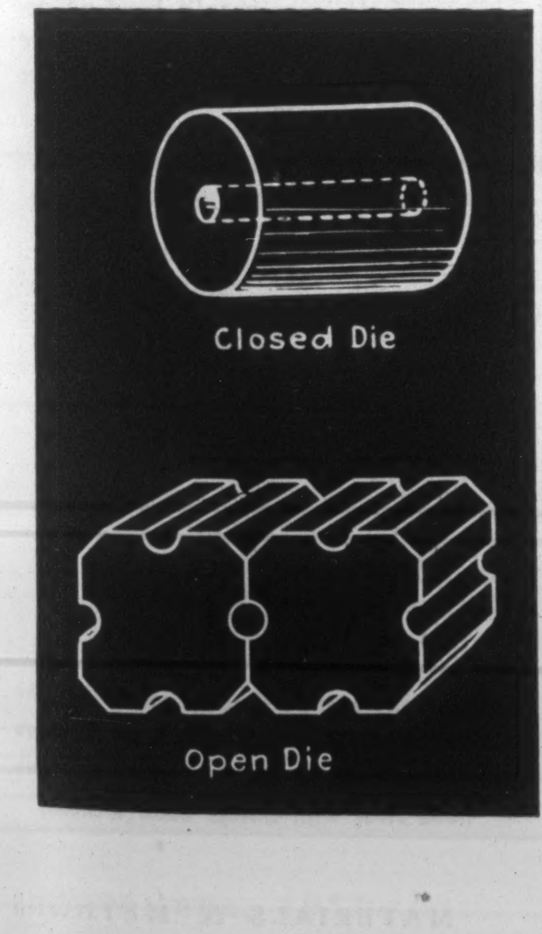


Collection of cold headed, specially shaped and threaded parts made by the Scovill Manufacturing Co. Parts with irregular shapes, lugs and eccentric contours cannot be made on a screw machine, but can often be cold headed.

Cold Heading Methods and Machines

It is as important to design a part for efficient manufacturing as it is to design it to perform well in its application. Many of the design limitations and possibilities of cold headed parts can only be appreciated with a general knowledge of die construction, head forming methods, and the cold heading machines. The parts designer should not, however, ever try to specify the exact production techniques to be used to cold head the part.

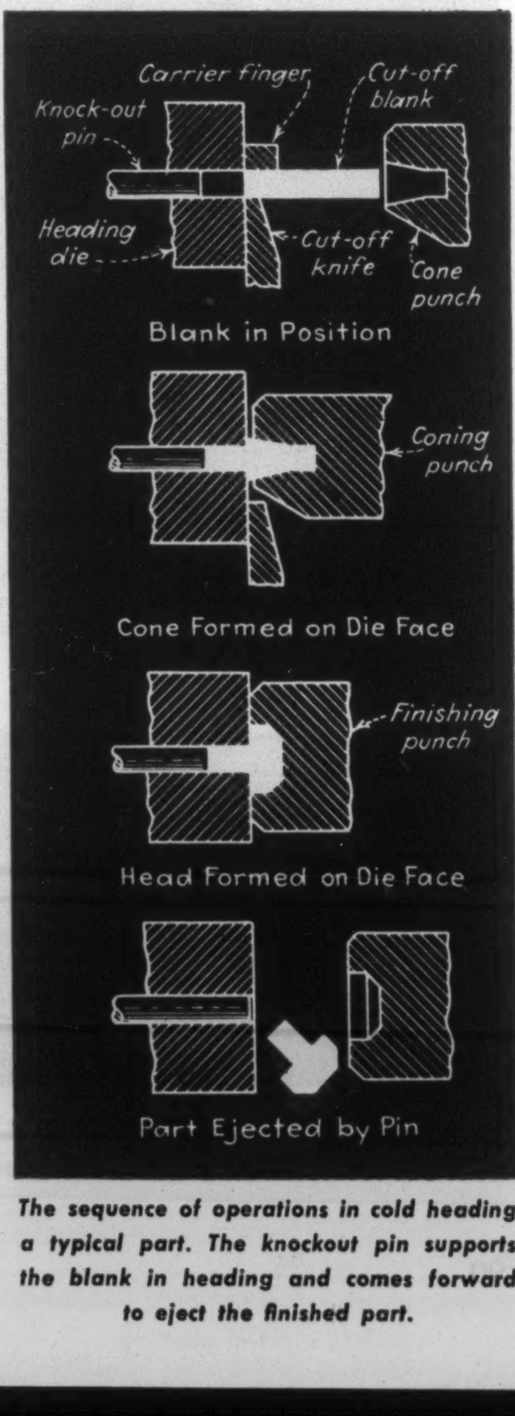
Two types of cold heading dies, open and closed, are used.



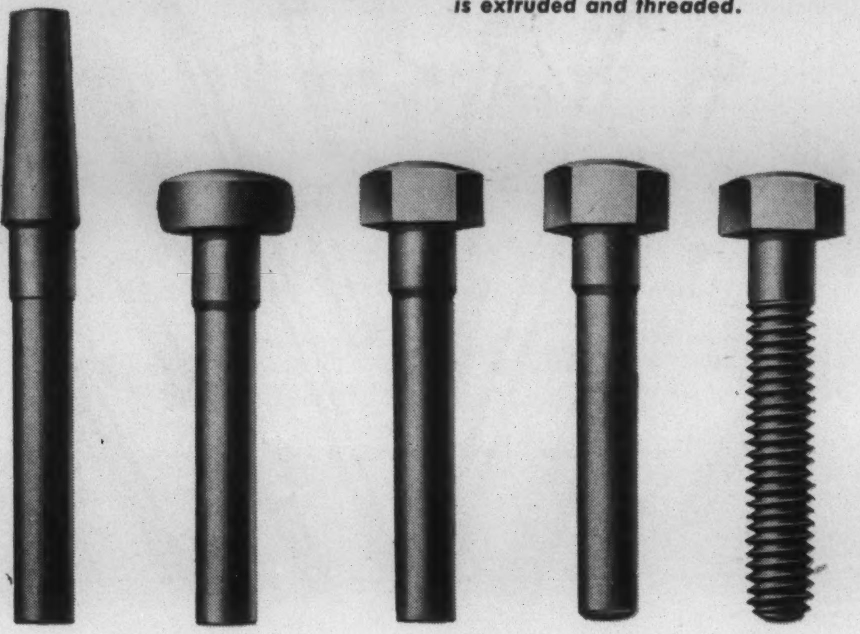
Heading Dies and Wire

There are two types of heading dies—solid and open. A solid die is a steel cylinder with an axial hole through it. A knock-out pin fills the hole at one end and supports the wire blank while the head is being formed by the punch. After the head is formed, the knockout pin moves forward to eject the part.

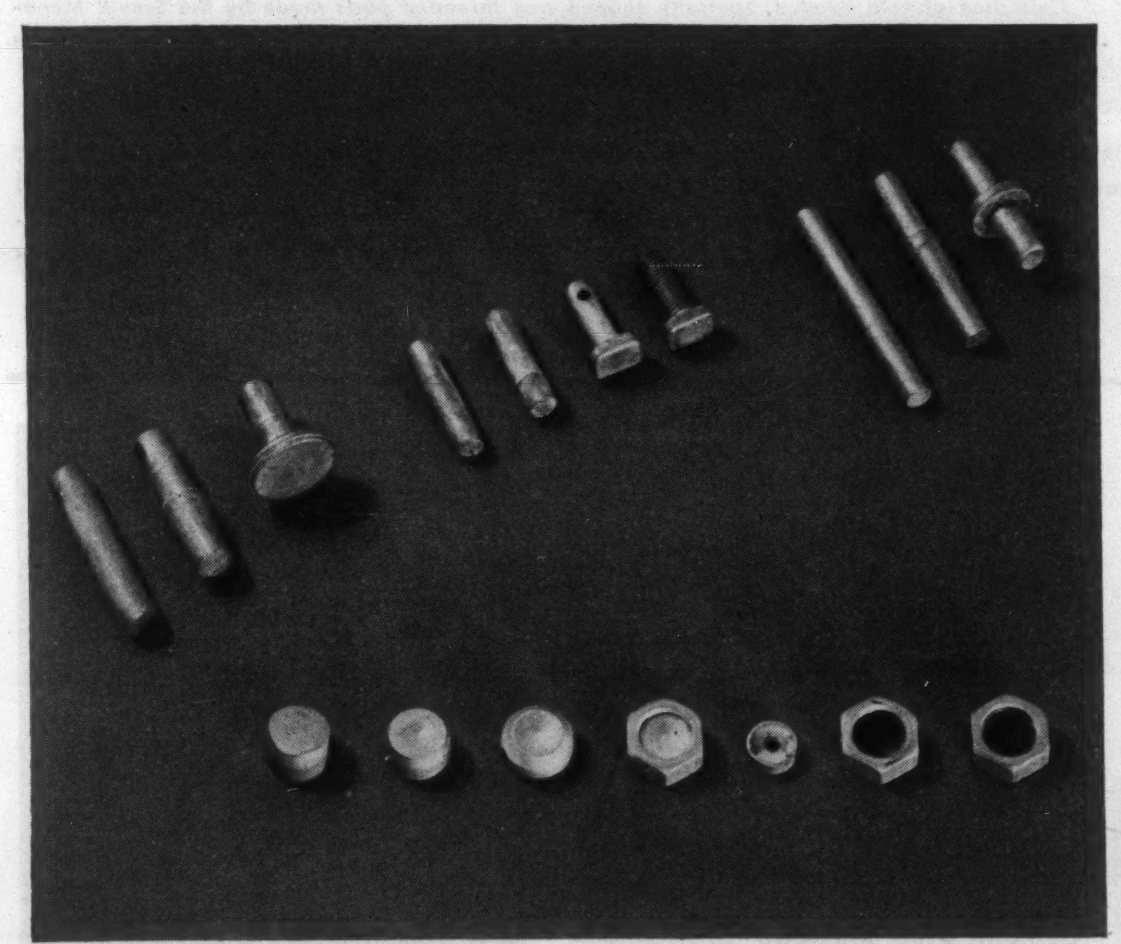
Open dies are two rectangular blocks of steel, each with half-holes running down each one of its four sides. The blocks can be faced together in four combinations to give four separate holes. The wire blank is clamped between the blocks while the head is being formed, and the dies open to release the part. No



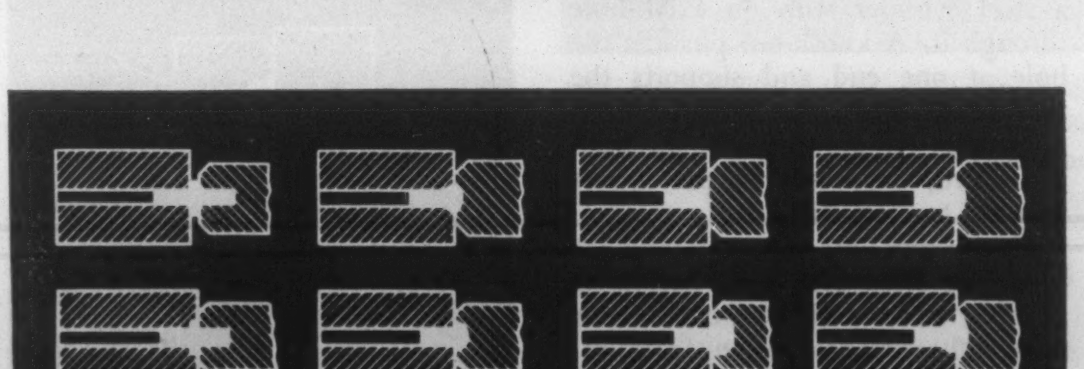
The sequence of operations in cold heading a typical part. The knockout pin supports the blank in heading and comes forward to eject the finished part.



This special screw is made in five steps by the Scovill Manufacturing Co. The blank is headed and clipped and the shank is extruded and threaded.



These cold headed products of the Bridgeport Brass Co. are shaped gradually by a number of blows and finishing operations. The flow of the metal can be controlled better when several blows are used.

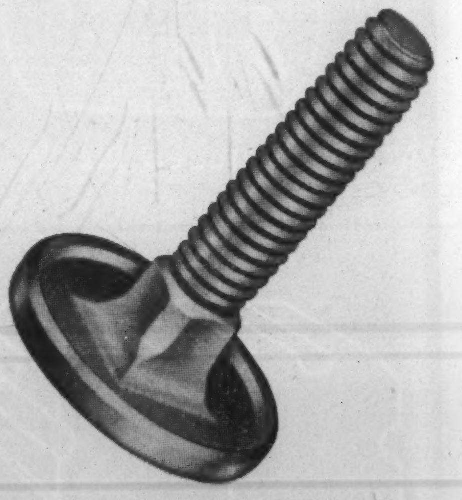


The head can be formed between the die and the punch or in cavities in either or both. The die and punch for a part are designed by the manufacturer.

knockout pin is needed to support or eject the part.

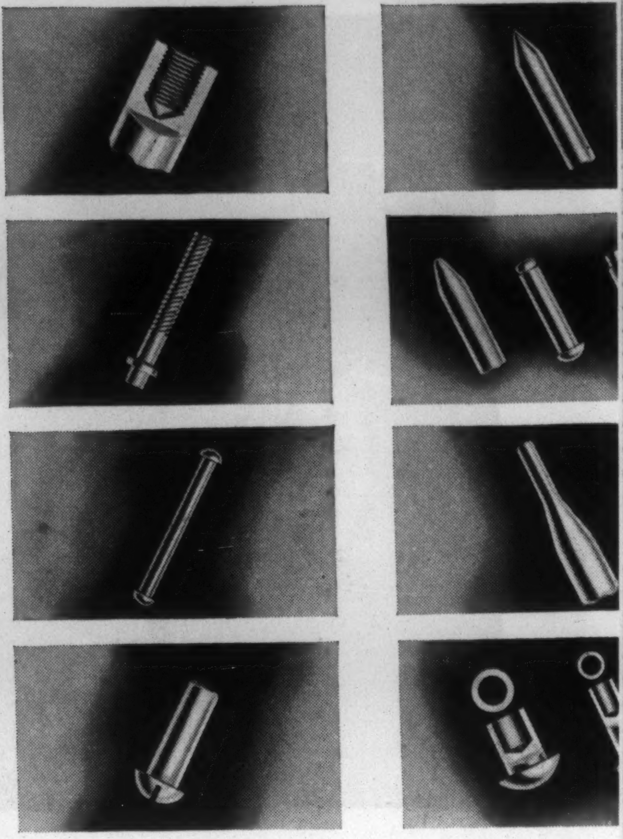
Solid dies are used for most parts. With open dies, a small flash or ridge of metal is sometimes left under the head of the part along the parting line between the two dies; a solid die eliminates the possibility of such a flash. Solid dies are also somewhat easier to make than open dies. Long parts are easier to make in open dies, however, since long shanks take a comparatively long time to come out of the die when the part is ejected and production is slowed up. One manufacturer figures that open dies are preferred for rivets whose length is over ten times the wire diameter. Solid dies can also be troublesome with wire blanks less than 1/16 in. in dia. In such cases, the knockout pin is so thin that it might not be sufficiently rigid to hold the blank during heading or to eject the finished part. Solid dies, on the other hand, can be used for parts with shorter shanks than are possible with open dies.

Wire stock for cold heading is specially ordered. It must be free of all injurious surface imperfections, since the heading operation will open even minor surface flaws into wide cracks. The wire is protected from corrosion, since rust on steel wire scores dies and stress cracks can develop in brass wire in storage. To provide lubrication in the dies, cold heading wire is made with special finishes and coatings. The coating or finish must have sufficient lubricating quality, plus enough adherence to prevent galling and unnecessary die wear. These coatings are the basis of many of the recent cold heading developments. Phosphate coatings have been used with success by a number of manufacturers.



This foot leveling screw, made by the Scovill Manufacturing Co., is a more severe cold heading job than a round or cone head rivet with thicker head sections.

These cold headed parts are being annealed after forming to relieve the residual stresses left in them by the cold working. Some parts are annealed after a few blows and then reheaded.

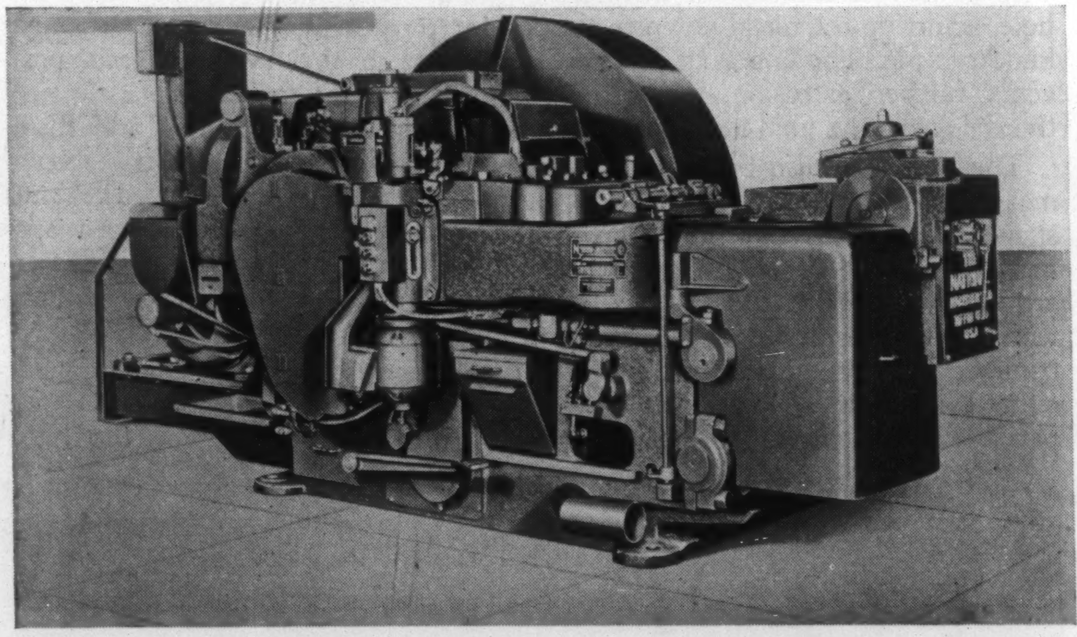


A number of secondary operations can be performed on cold headed parts. These views, supplied by John Hassal, Inc., illustrate drilling, swaging, milling, pointing, slotting, reheading, special threading and tapping.

Upsetting Operations

Upsetting the Head—The forming operation that the punch performs is called a *blow*. This terminology is somewhat misleading, however, since the metal is actually squeezed rather than hammered into shape.

Cold heading may require one, two, three or even more blows. The number required depends on the volume to be upset, the metal that is used and the shape of the head. These factors are evaluated by the parts manufacturer, and the choice of the number of blows to be used is made on past experience. Purely for estimating purposes, the general rule for low carbon steel is that a length of wire equal to 2¼ times the wire diameter can be upset with one blow and up to 4½ diameters with two blows. These limits decrease slightly with less ductile metals. Three or four blows are used when the head cannot be formed by two strokes. Unless the metal work hardens particularly slowly, however, annealing is required between the second and the third blow.

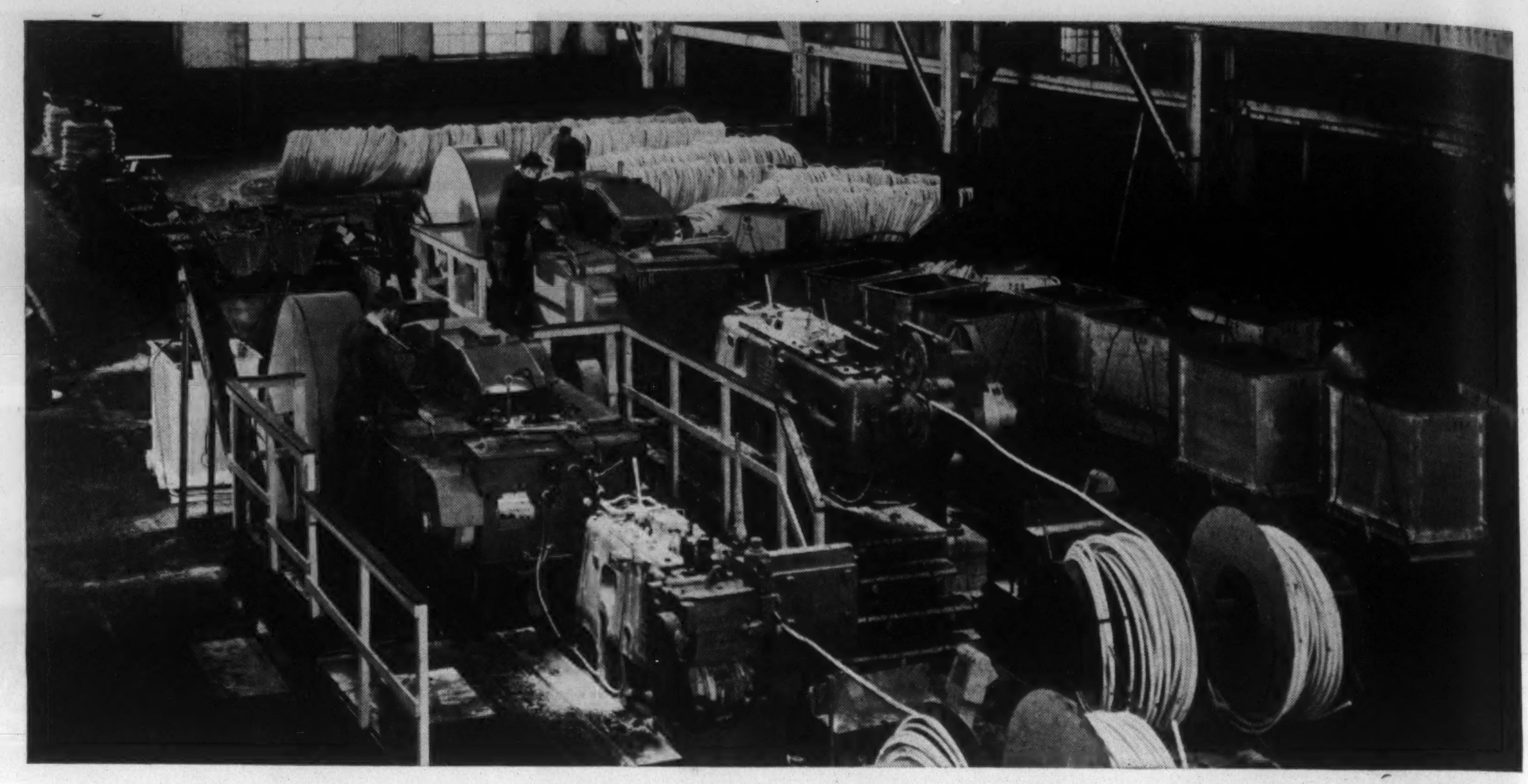


Special machines are used to cold head many production items. Many bolts are made on boltmakers like this one, built by the National Machinery Co.

The amount that can be upset in one blow is actually limited more by the need to control the metal flow than by the special properties of the alloy. If too much is upset in one blow, the wire may buckle or the head may be lopsided. If two or more blows are used, the metal is shaped in gradual steps to keep the material flowing in the right direction to form a sound head on the final blow. The first and intermediate blows, known as coning punches or stover blows, gather the metal into a flat top cone, pointed toward the punch. The last blow forms the final head.

Heads can be formed on both ends of a part, too. With open dies, this is done in a single operation. A more common practice, however, is to head one end conventionally, then feed the part into another machine to head the opposite end.

Other Operations—The shank of a cold headed part can be extruded in a solid die to give sections of smaller



A pair of cold rivet headers with wire drawers at the Lebonon plant of the Bethlehem Steel Co. Wire drawn just before heading can be upset somewhat more severely.

diameter than the original wire. The hole in the die necks down and the wire blank rests on the tapered shoulder in the hole when it is put into the die. When the punch comes down to form the head, it forces the wire down into the smaller diameter hole, squirting the metal down to the knockout pin. The knockout pin prevents further extrusion, supporting the shank for the final head forming.

The upset can also be trimmed to make a hex, square or specially shaped head. It is difficult to upset hex or square heads, and many standard fasteners are actually cold headed with round fillister heads which are trimmed to shape. This can be done either by a trimming punch while the part is still in the die, or in a subsequent operation.

Thread rolling is another important secondary operation. Like cold heading, it is a cold forging operation. Rolled threads have several advantages over cut threads. Closer dimensional fits can be obtained, and the threads themselves are stronger because of the favorable grain positioning in the metal.

Many other machining and forming operations can be used to complete a cold headed part. The ends can be drilled, pointed, swaged, special threaded, slotted or tapped. Further shaping on automatic milling machines is often employed.

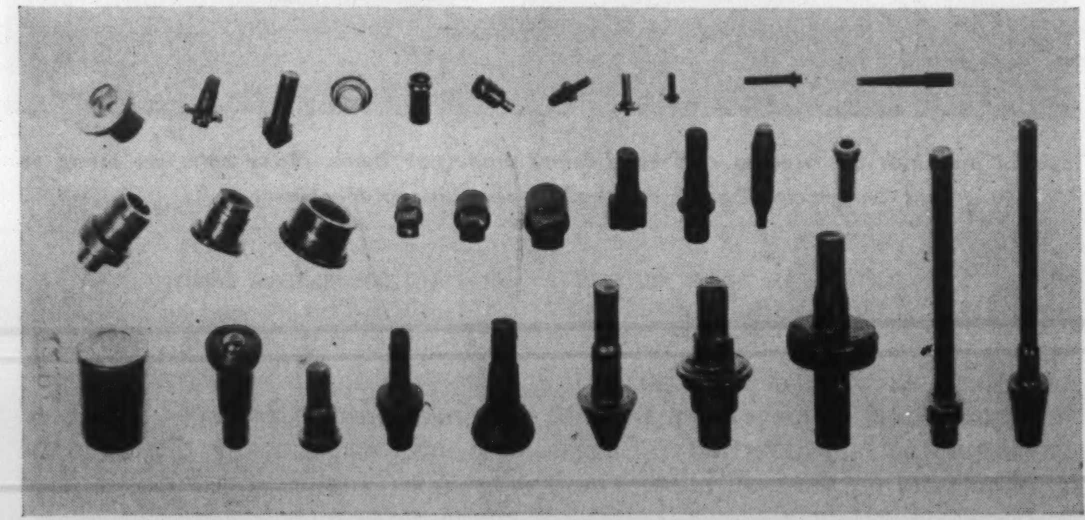
Cold Heading Machines

Cold headers are, for the most part, classified according to the number of blows each part receives. Their operating principles and mechanisms vary widely. A universal characteristic, however, is their automatic operation; in production, the machine feeds the wire and drops the finished parts. In general, the larger the machine, the slower it operates.

The single-blow header is used when the volume of metal in the head is relatively small and the head shape is easy to form. These machines are used with wire up to ¾ in. in dia; outputs range from 35 to 400 parts per min. One-blow headers now make many parts that formerly required two blows. In the old machines the alignment was inaccurate and the dies and punches were springy, so that two blows were needed to form a head in which the metal flow can now be controlled with one blow.

Double- and triple-blow headers work the same way as the single blow type, except that the wire blank is hit by several punches before it is taken out of the die. The majority of cold headed parts is made in double-blow machines, which use wire up to 1 in. in dia, turning out up to 250 parts per min.

The progressive header is a multi-blow machine in which the part is transferred from one die to another as it is formed. Three or four blows are used. These machines are particularly suitable for heads that cannot be formed in a double-blow machine.



These parts were made on a National Machinery Co. progressive header. These machines produce many parts that were formerly considered too complex for cold heading.

One advantage of the progressive header is that the die cavities as well as the punch cavities change progressively as the head is formed.

Many parts that are completed in a progressive header without annealing would require an intermediate normalizing heat treatment if they were taken from a double-blow header and fed into a reheader for completion. The explanation is that once the metal starts to deform, it can be shaped more severely without cracking if the whole deformation is carried out immediately. The same phenomenon is used on some severe heading operations, where the wire is drawn to size as it is fed into the machine. Larger upsets can be made on this wire than on wire that is drawn and allowed to age before heading. There is no agreement as to a satisfactory theoretical explanation for this behavior.

Specialized cold heading machines are used for standard parts which are produced in very large quantities. Typical products of special headers are balls, rollers, standard bolts and standard nuts. The largest ball header makes 85 1⅛-in. balls per min. The smallest balls are 0.059 in. in dia, and are cold headed from 0.046-in. wire at the rate of 350 per min. Ball headers are solid die, single-blow machines with knockout pins in both the die and the punch. Bolts are made on special boltmakers in which the heads are formed and the parts are automatically transferred to other stations in the machine to be pointed and threaded. The nut-former is an adaptation of the progressive header in which most of the material from the hole goes into the nut, leaving only a thin center slug as scrap.

Special feeding mechanisms are required on re-heading machines which put the second head on double-headed parts or perform further heading operations on annealed parts. Hand feeding is employed on short runs, but automatic feeding hoppers can be used on long production jobs.

Metals and Alloys for Cold Heading

Table 1—Cold Heading Metals

Metal	Comparative Cold Heading Qualities	Main Uses
Low and Medium Carbon Steels	(AISI Specifications) *Excellent:* C1008, C1010, C1013, C1016, C1017 *Good:* C1018, C1020, C1022, C1024, C1030, C1035, C1038, C1108, C1109 *Fair:* C1040, B1010	Machine bolts, cap screws, wood screws, sheet metal screws, recessed head screws, socket head screws, set screws, scrapless nuts, nails, rivets and machine parts. The low carbon steels can be case hardened, while the medium carbons can be case hardened or heat treated. Free machining steels give stiffness (nails).
Alloy Steels	(AISI Specifications) *Excellent:* 3115,4017 *Good:* 2330, 3120, 3130, 4615, 5120, 8620, 8720 *Fair:* 1335, 3135, 3140, 4037, 4042, 4130, 4137, 4140, 4340, 4640, 5140, 6150, 8635, 8640, 8740, 50100, 51100, 52100	Machine bolts, cap screws, socket head screws, recessed head screws, socket head cap and set screws, place bolts, anti-friction balls and rollers, cams, connectors and special machine parts. Alloy steels are not used as much as plain carbon steels. They can be heat treated and, in some cases, carburized for superior qualities.
Stainless Steels	*Fair:* 302, 303, 304, 305, 410, 420, 430, 440	Bolts, screws and nuts. Stainless steels are difficult to cold head because they work harden quickly. They are used for corrosion resistant parts.
Aluminum	*Excellent:* 2S, 3S, 14S, 17S, A17S, 24S, 52S, 53S, 56S, 61S	Rivets, electrical parts. Aluminum has good ductility but the low strength limits the spread that can be obtained without fracture.
Copper Alloys	*Excellent:* Copper, Yellow Brass, Cartridge Brass, Low Brass, Red Brass, Commercial Bronze, Nickel-Phosphorus Bronze *Good:* Phosphor Bronze, Nickel-Silver, Silicon Bronze (B)	Studs, electrical terminals, eccentrics, buttons, screws, nuts and bolts. Copper alloys, except free-cutting alloys, cold head extremely well. Biggest applications are in electrical parts and corrosion resistant fasteners.
Nickel Alloys	*Excellent:* Nickel *Fair:* Monel, K-Monel, Inconel, Duranickel	Screws, nuts, bolts, special machine parts.

The choice of the metal for a cold headed part depends on the heading characteristics of the metal as well as the application of the part. The designer makes his choice from the wide selection of alloys with which the parts manufacturers have had experience. The low and medium carbon steels and some alloys of steel, aluminum and brass are the most common cold heading materials. Beryllium copper, phosphor bronze, silicon bronzes, nickel silver, monel, Invar, lead, zinc, silver and gold are also cold headed successfully.

No one of the standard test properties—tensile strength, impact strength or ductility—is a really good index of the cold heading qualities of a metal. Perhaps the most important characteristic is malleability. Very soft and very hard alloys do not usually make good cold heading materials; the hard metals tend to crack and the soft metals are spongy and stick to the die. If anything, the trend has been to stronger, tougher alloys. In general, cold heading metals should have ductility in order to flow, shear strength to prevent cracking as the head spreads, and a low rate of strain hardening so that a large volume can be upset without annealing. When the shank of the part is extruded, some stiffness is also desirable. Direct experiment is the only reliable guide to the heading properties of an alloy.

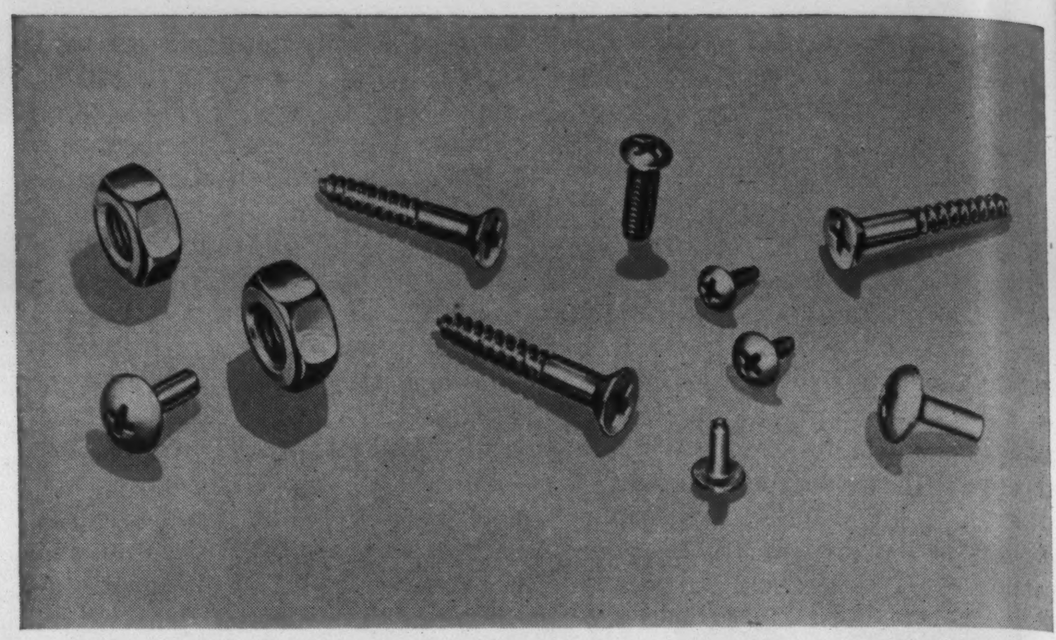
Carbon Steels

Medium hardness and good malleability are the main requirements in a cold heading steel. The free machining elements—sulfur, lead, phosphorus and silicon—cannot be present in appreciable amounts, since a good machining steel tends to crack in heading. Phosphorus and sulfur are usually limited to 0.05% each, and silicon to 0.10%. Alloying elements, like manganese, nickel, chromium, molybdenum and vanadium, reduce the cold workability of steel and also seem to encourage cracking. Molybdenum, however, may help in small quantities.

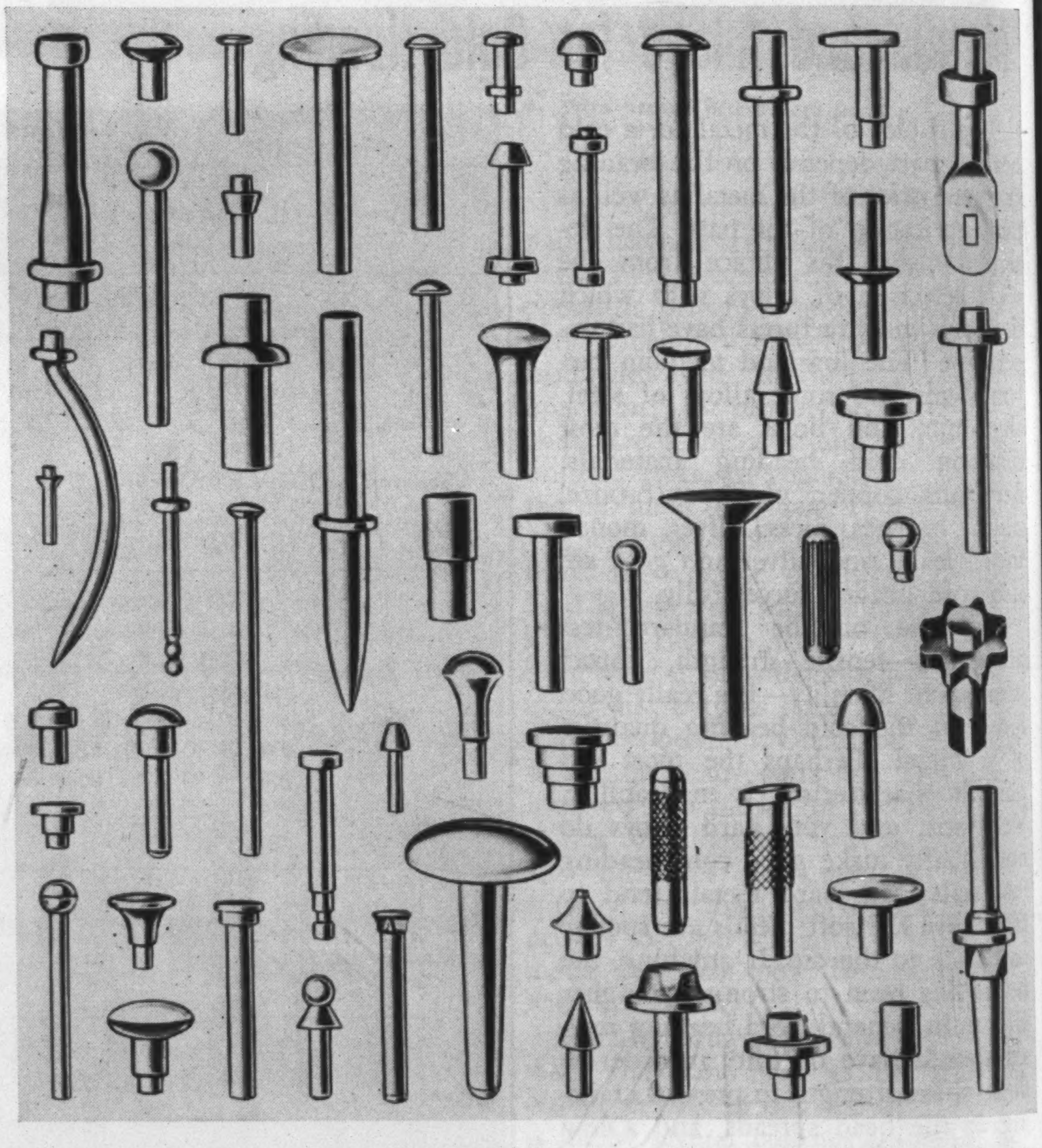
The carbon content of cold heading steel varies widely. The most commonly used and the most generally economical wire is 0.10 to 0.15% carbon. Steels below 0.12% carbon are easy to work, but are subject to excessive grain growth, and very little wire under 0.08% is used now. In the higher carbon ranges, screws are made of 0.15 to 0.25% carbon steel, and 0.25 to 0.45% grades are used in parts that need the physical properties that can be obtained by heat treating.

Coarse grained steels in the low carbon ranges are sometimes used for their special case hardening properties. Parts made from these steels are usually cold headed from 7/16 in. or smaller wire. The plastic flow of the metal is good, but the post-heading heat treatment often causes cracks, especially in the larger parts.

The free-cutting steels of the 1100 and 1300 series are unsuitable for cold heading. Exceptions to this rule are C1108 and C1109, used in cold headed parts with cut threads. Resulfurized open hearth steel is also used successfully for parts that must be both cold headed and machined.



A special chromium-nickel austenitic stainless steel that work hardens more slowly than conventional 18:8 stainless has been developed by the Carpenter Steel Co. for parts like these.



These special products were all cold headed by John Hassal, Inc. Many cold headed parts are not fasteners at all, but serve as small machine parts. Toys and business machines are typical applications.

Alloy Steels

The low alloy steels with 0.40% or less carbon can also be cold headed. They cannot be as severely upset as the plain carbon steels, however, and are by no means as widely used. The procurement of alloy steel wire with the temper and finish required for cold heading is often difficult.

High carbon chromium steel can be cold headed, however, if the wire is thoroughly annealed. In anti-friction bearing balls, for instance, carbon runs as high as 1.10% and chromium as high at 1.80%. In the dead soft, annealed state this steel works readily enough.

Nickel steels can also be cold headed, within limits. Although nickel adds toughness to steel in most tests, a high nickel content in a cold heading steel encourages cracking on severe upsets. An alloy of 1.5% nickel works well enough in the annealed state, but cold heading becomes tricky as the nickel content increases. While 3.5% nickel steel can be upset cold, it is usually considered difficult to work and hard on the dies.

Straight chromium stainless steels (410, 420, 430 and 440) are standard heading alloys. While the austenitic stainlesses (AISI 302, 303 and 305) can be cold headed, some difficulty might be encountered because they work-harden rapidly. With these austenitic stainlesses, and with the nickel bearing steels in general, successful cold heading depends upon using the right grade of wire.

Copper Alloys

Copper alloys are among the most important cold heading materials. Only the carbon steels are more widely used. Brass, low silicon bronze, nickel silver, beryllium copper, phosphor bronze, monel and other copper alloys are cold headed into nuts, bolts, nails, screws and fittings. The requirements for cold heading in copper alloys are similar to those in steels. Free cutting alloys are unsatisfactory, and alloys that work harden rapidly are limited in the allowable upset volume.

Commercial copper is an extremely good cold heading material. Larger volumes can be upset on copper wire than are possible with even low carbon steel. Any of the copper-zinc alloys from 95-5% to 65-35% cold head easily; the free cutting brasses, on the other hand, are difficult to upset successfully. The nonleaded high brasses, 60 to 70% copper, cannot usually be upset as severely as low carbon steel (3 diameters in 2 blows for the brass against 4½ diameters for steel), but as the copper content increases, the allowable volumes also go up. The leaded high brasses should not be specified for cold heading, and if a combination headed-machined part is required in brass, the cold headed parts manufacturer should be consulted in the choice of the alloy.

For most purposes, the best combination of physical properties, including tensile strength and elongation, is found in cartridge brass (70-30). For severe cold heading and extruding applications, like tubular rivets, cartridge brass is furnished in a special light drawn temper with a tensile strength of 50,000 to 60,000 psi; a slightly harder temper, 58,000 to 72,000 psi, is used for conventional screws; for high quality recessed head screws, an even harder temper, 70,000 to 80,000 psi, is preferred.

The copper-tin alloys are not as easy to cold head as the brasses. Some bronze alloys tend to crack under cold heading. Phosphor bronze, from 95-5% to 90-10% copper-tin, can be headed only to a limited extent, depending on the quality of the wire and the head style desired. The low silicon bronzes (B) have excellent heading characteristics at tensile strengths of 80,000 to 90,000 psi, while the high silicon bronzes (A) are short on ductility on difficult upsets. About three diameters can usually be upset on medium strength low silicon bronze (B) cold heading wire.

Other Metals

Aluminum is highly ductile and cold heads easily. To some extent, however, the low shear strength of the metal limits the total spread that can be obtained. Rivets and screws are usually made from commercially pure aluminum, 2S or 3S. Where greater strength is required, 17S, A-17S, 24S, 53S or 61S can be used; 53S is used for marine parts, and tempered alloys are recommended for nails.

Nickel and nickel alloy cold headed parts are also made. The main problem with these materials, as with austenitic stainless steels, is the rapid work hardening of the metal. The initial ductility of nickel, Inconel, monel, K Monel and Duranickel is good and their heading characteristics are similar to those of alloy steels, except that the total head volumes obtainable are less. The free machining K Monel and KR Monel are not recommended for cold heading, since they do not have the clean metallurgical structures required for cold forming.

Special cold headed parts are sometimes made from other metals. Lead rivets for storage batteries and balance weights are made from pure lead or antimonial alloys. Lead is soft and shows no strain hardening, but is weak enough to split in a severe heading operation. Platinum and gold are also cold headed into instrument and jewelry parts. Rivets have been cold headed from commercially pure titanium wire, type Ti-75A. The galling characteristics of titanium are overcome by a slight oxide scale on the wire or a flash copper coating.

Designing Cold Headed Parts

During World War II, one manufacturer with both cold headers and screw machines was overloaded with government orders for parts specified for screw machine manufacture. The company engineers found that many of the parts could actually be made better and cheaper by cold heading, with specification and design modifications. Few of these modifications affected performance of the parts, and the government engineers accepted the change to cold heading readily. The parts designers had just neglected to consider cold heading as a possible fabrication method, and the drawings and specifications had been made with only screw machining in mind.

In private industry, too, the potentialities of cold heading have not

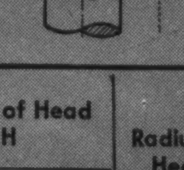
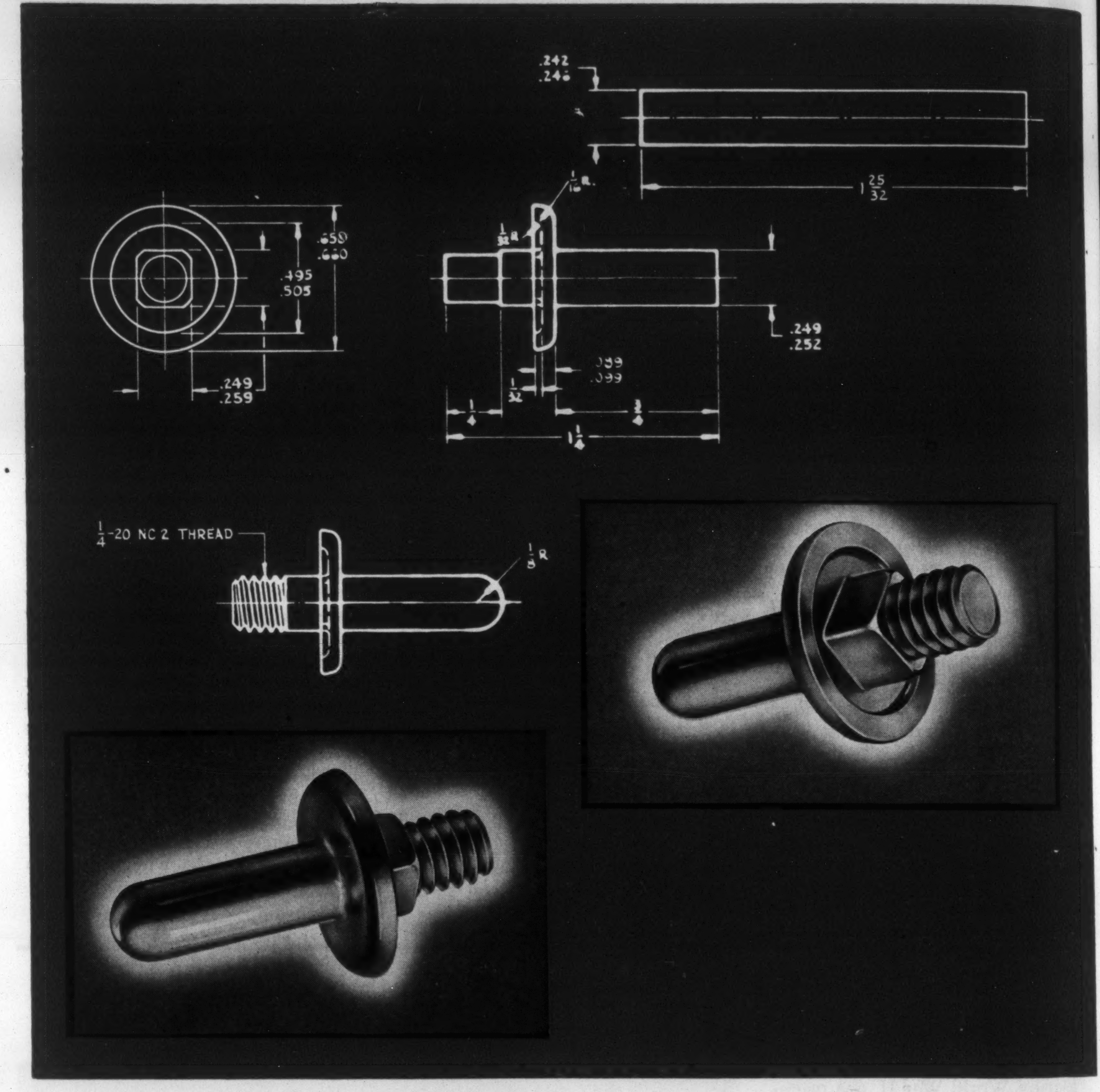


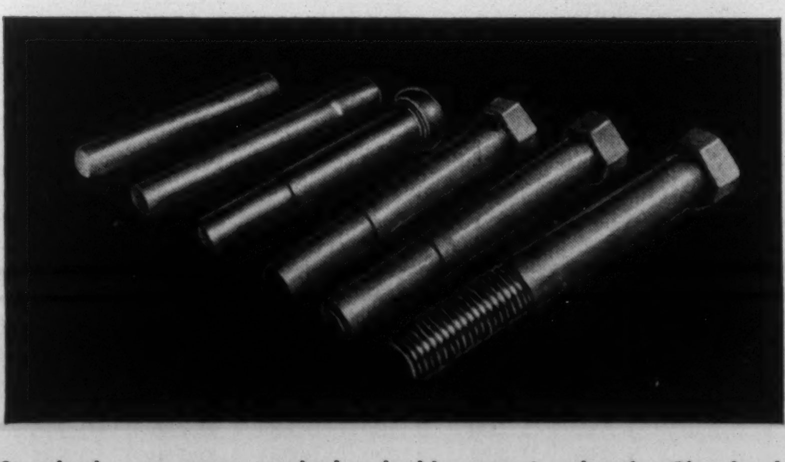
Table 2—Large Button Head Rivets

Nominal	Diameter of Body D		Diameter of Head A			Height of Head H		Radius of Head G
	Max	Min	Basic	Max	Min	Max	Min (Basic)	
1/2 0.500	0.520	0.478	0.875	0.938	0.844	0.406	0.375	0.443
5/8 0.625	0.655	0.600	1.094	1.157	1.063	0.500	0.469	0.553
3/4 0.750	0.780	0.725	1.312	1.390	1.281	0.593	0.562	0.664
7/8 0.875	0.905	0.850	1.531	1.609	1.500	0.687	0.656	0.775
1 1.000	1.030	0.975	1.750	1.828	1.719	0.781	0.750	0.885

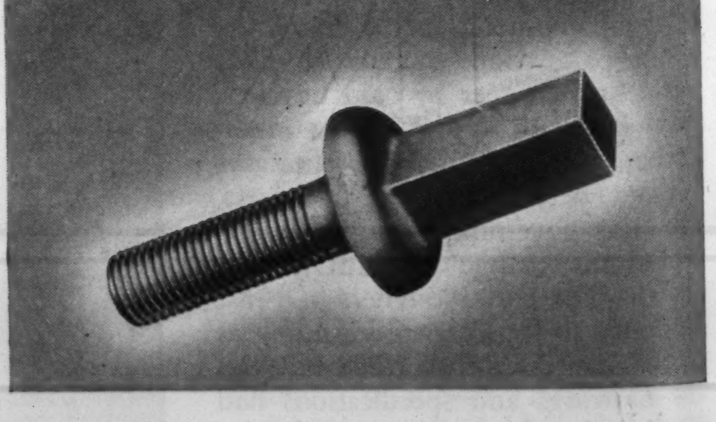
Fillets under the head not more than 1/8 in. in radius.


.242
.246
$1\frac{25}{32}$
$\frac{1}{16}$R.
$\frac{1}{32}$R
.650
.660
.495
.505
.249
.259
.249
.252
.089
.099
$\frac{1}{32}$
$\frac{1}{4}$
$\frac{3}{4}$
$1\frac{1}{4}$
$\frac{1}{4}$-20 NC 2 THREAD
$\frac{1}{8}$R

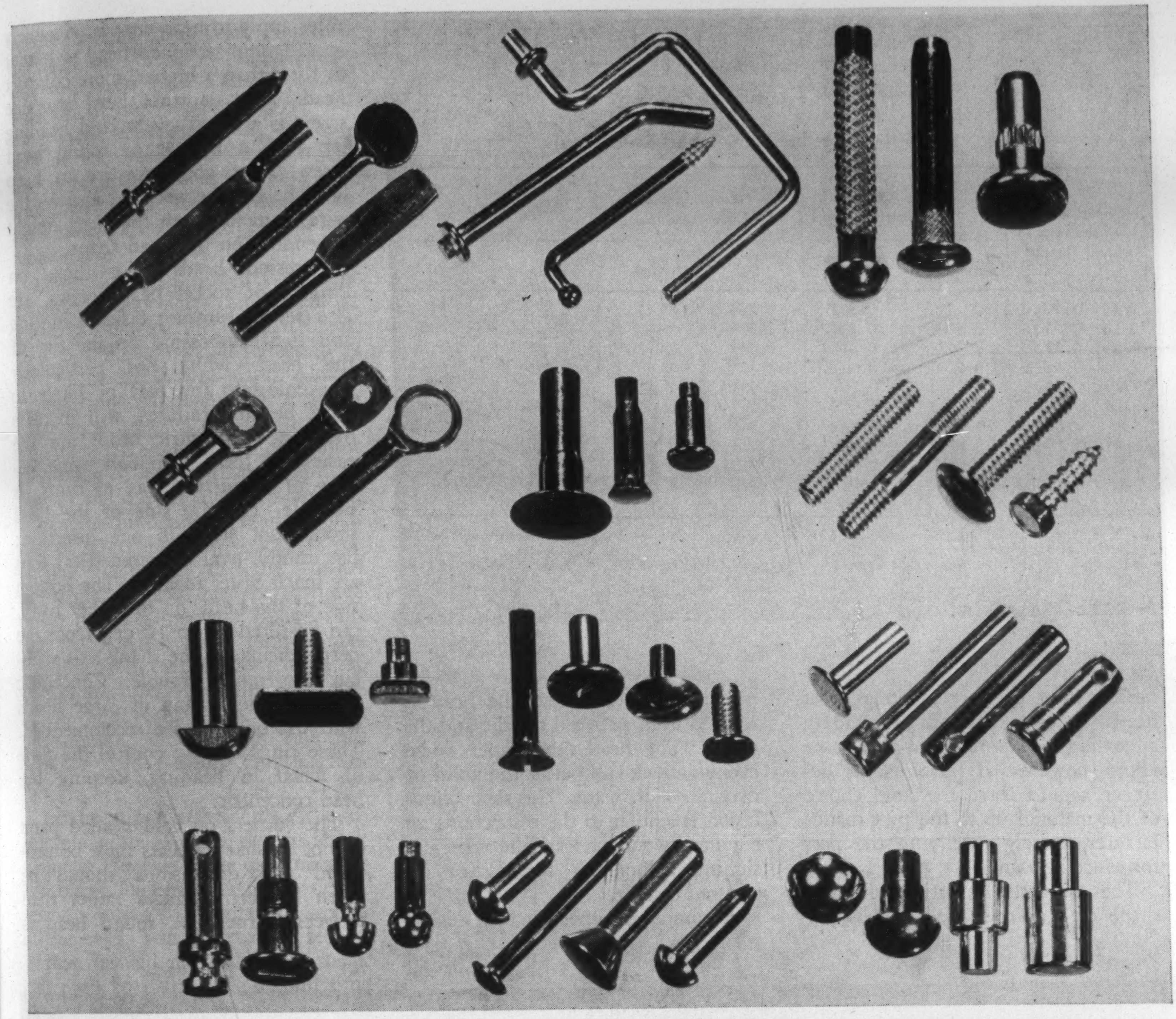
A typical cold headed part made by the Scovill Manufacturing Co. The tolerances on all dimensions should be specified as wide as possible to facilitate manufacture.



Standard cap screws made by double extrusion by the Cleveland Cap Screw Co. The head is formed on a short unextruded section at the top of the blank. Comparatively larger heads can be made in this way and a stronger part results.



An industrial fastener cold headed by the Scovill Manufacturing Co. Corners should be filleted on cold headed parts and the edges are not sharp unless subsequent machining is used.



The Townsend Co. cold heads these specialties. On many parts finishing operations after cold heading are required.

been fully developed outside the fastener industry. Even some parts to be made by cold heading are actually designed as screw machine parts by force of habit. When a part is laid out as a casting, a forging or a weldment, it should be designed to fit both the application it is intended for and the manufacturing process that will be used to make it. The same dual objective should be kept in mind in designing a cold headed part. The designer should modify the part to fit cold heading as much as possible within the application limitations.

Materials and Shapes

The application of a cold headed part primarily determines the metal used. The choice of material will affect the price of the part, but its shape is independent of the alloy

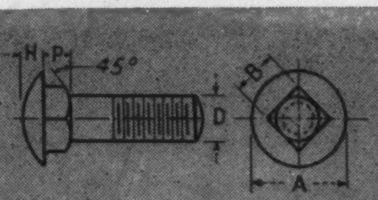


Table 3—Square Neck Carriage Bolts

Nominal Dia of Bolt D	Dia of Head A		Height of Head H		Width of Square B		Depth of Square P	
	Min	Max	Min	Max	Min	Max	Min	Max
No. 10	7/16 0.438	0.469	3/32 0.094	0.114	0.185	0.199	0.188	0.219
1/4	9/16 0.563	0.594	1/8 0.125	0.145	0.245	0.260	0.219	0.250
5/16	11/16 0.688	0.719	5/32 0.156	0.176	0.307	0.324	0.250	0.281
3/8	13/16 0.813	0.844	3/16 0.188	0.208	0.368	0.388	0.281	0.312
7/16	15/16 0.938	0.969	7/32 0.219	0.239	0.431	0.452	0.313	0.344
1/2	1 1/16 1.063	1.094	1/4 0.250	0.270	0.492	0.515	0.344	0.375
9/16	1 3/16 1.188	1.219	9/32 0.281	0.312	0.554	0.579	0.375	0.406
5/8	1 5/16 1.313	1.344	5/16 0.313	0.344	0.616	0.642	0.406	0.437
3/4	1 9/16 1.563	1.594	3/8 0.375	0.406	0.741	0.768	0.469	0.500
7/8	1 13/16 1.813	1.844	7/16 0.438	0.469	0.865	0.895	0.531	0.562
1	2 1/16 2.063	2.094	1/2 0.500	0.531	0.990	1.002	0.594	0.625

Max radius of fillet under head of bolt for sizes No. 10 (0.1900) to ½ in., inclusive, shall be 1/32 in. and for sizes 9/16 to 1 in., inclusive, shall be 1/16 in.

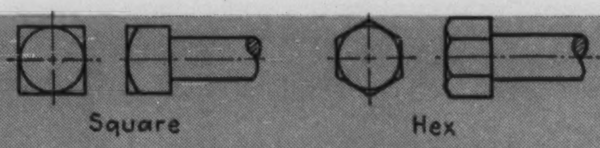


Table 4—Regular Unfinished Bolt Heads

Nominal Size or Basic Major Dia of Thread		Width Across Flats		Width Across Corners, Min.		Height	
		Max (Basic)	Min	Sq	Hex	Max	Min
1/4	0.2500	0.3750	0.362	0.498	0.413	0.188	0.156
5/16	0.3125	0.5000	0.484	0.665	0.552	0.220	0.186
3/8	0.3750	0.5625	0.544	0.747	0.620	0.268	0.232
7/16	0.4375	0.6250	0.603	0.828	0.687	0.316	0.278
1/2	0.5000	0.7500	0.725	0.995	0.826	0.348	0.308
9/16	0.5625	0.8750	0.847	1.163	0.966	0.396	0.354
5/8	0.6250	0.9375	0.906	1.244	1.033	0.444	0.400
3/4	0.7500	1.1250	1.088	1.494	1.240	0.524	0.476
7/8	0.8750	1.3125	1.269	1.742	1.447	0.620	0.568
1	1.0000	1.5000	1.450	1.991	1.653	0.684	0.628

Taper of the bolt heads (angle between one side and the axis) shall not exceed 2 deg, the specified width across the flats being the largest dimension.

Maxium radius under the head of bolts for sizes ¼ to ½ in. shall be 1/32; for sizes 9/16 to 1 max, radius shall be [illegible].

used, except on very severely upset heads. Intermediate or postheading annealing may be required with some alloys, however. If possible, the designer should leave the final choice of the material up to the part manufacturer, merely specifying the performance he wants.

The biggest limitation on the shape of a cold headed part is imposed by the fact that the head is formed in or between the die and the punch. The head must taper down evenly, above and below the point of maximum diameter. The shape limitation is similar to the restrictions an engineer would meet if he were designing a hot die forging or an uncored casting.

A number of other practical design rules apply to head shapes. A widely spread, thin-sectioned head is harder to form than a higher, more compact head. Thus, a truss head machine screw is a more severe cold heading job than a fillister or round head screw. It is good practice to keep head heights between ¼ and ¾ the wire diameter, with the exact height depending on the head shape.

Recessed heads, like those on Phillips or socket head screws, are also severe forming tasks. Lettering and light embossing on the top of the head, while not particularly weakening to the part or likely to cause heading failures, will increase the cost. Concentric heads are the easiest to form, although some degree of eccentricity, as in cams, is possible. The top side of the head should not slope in one direction; flat, round, oval or symmetrical tops are much easier to head. The bottom side of the head, on the other hand, can be tilted up to 12 deg from the perpendicular to the shank axis without too much trouble. Concentric rings on the bottom of large heads with flat bottoms are recommended. These rings help to control the flow of metal in heading, keeping the head concentric.

The corners on cold headed parts cannot be sharp. Fillets must be provided and dimensions should be given between surfaces rather than between corners. A round head is

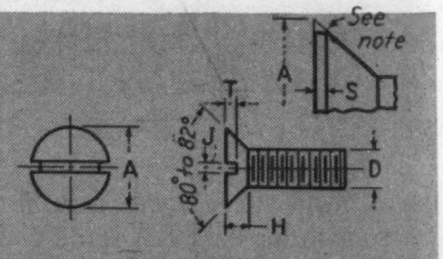


Table 5—Slotted and Recessed Head Screws

	D	A			S	H		J		T	
Nominal Size	Max Dia of Screw	Head Diameter			Flat on Min Screw	Height of Head		Width of Slot		Depth of Slot	
		Max Sharp	Min Sharp	Absolute Min with Max S		Max	Min	Max	Min	Max	Min
10	0.190	0.385	0.359	0.348	0.007	0.116	0.098	0.060	0.050	0.053	0.034
12	0.216	0.438	0.410	0.397	0.008	0.132	0.112	0.067	0.056	0.060	0.039
1/4	0.250	0.507	0.477	0.462	0.009	0.153	0.131	0.075	0.064	0.070	0.046
5/16	0.3125	0.635	0.600	0.581	0.011	0.191	0.165	0.084	0.072	0.088	0.058
3/8	0.375	0.762	0.722	0.700	0.013	0.230	0.200	0.094	0.081	0.106	0.070
7/16	0.4375	0.812	0.771	0.743	0.016	0.223	0.190	0.094	0.081	0.103	0.066
1/2	0.500	0.875	0.831	0.802	0.018	0.223	0.186	0.106	0.091	0.103	0.065
9/16	0.5625	1.000	0.950	0.919	0.020	0.260	0.220	0.118	0.102	0.120	0.077
5/8	0.625	1.125	1.069	1.035	0.023	0.298	0.253	0.133	0.116	0.137	0.088
3/4	0.750	1.375	1.306	1.267	0.027	0.372	0.319	0.149	0.131	0.171	0.111

Edges of head may be rounded.

The radius of the fillet at the base of the head shall not exceed twice the pitch of the screw thread.

easier to cold head than a square, hexagon or other flat sided upset; the corners on a flat sided upset are difficult, if not impossible, to fill completely, especially along the bottom of the head. One way around this is to upset the head round and trim it to get flat sides, although this adds an extra machine operation and more scrap.

Limits are also placed on shank extrusion. Small wires can be reduced down to 60% of the original blank area, but the allowable reduction is smaller in large wire sizes. Almost all extrusion is done with a sharp angle cone between the two sections. The included angle of this cone must be 30 deg or less, so that the abruptness of the section change is limited. When the unthreaded shoulder of a bolt or screw must be as wide as the outside diameter of the rolled threads, the shank must be extruded down to pitch diameter before rolling the threads. Since long shanks are difficult to extrude, long threaded shanks are usually machine threaded, unless the threads can be larger than the shoulder. Good design can thus combine cold heading and machining.

Extrusion can also increase the allowable ratio of head size to shank diameter. In this technique, most of the blank length is extruded down, leaving only a short enlarged section at the head. This unextruded section is then headed normally. The shank can even be extruded a second time in the heading operation. In this way, head volumes well over eight times the finished shank diameter can be formed without annealing.

Tolerances

The best guide to cold heading tolerances are the standards that have been developed by the ASME for cold headed bolts, screws and rivets. These tables are based on good manufacturing practice for standard parts. They indicate the limits a skilled manufacturer can hold on long production runs on each type of dimension on a cold headed part. By no means are these limits representative of the closest tolerance that can be held on cold headed parts, however.

Tables 2, 3, 4, 5 and 6 show the range of tolerances specified for standard fasteners. In each case, the tolerances are made as wide as possible for the part application. Extremely wide limits are allowed on the large rivet heads (Table 2), while the tolerances on standard bolts and machine screws (Tables 4

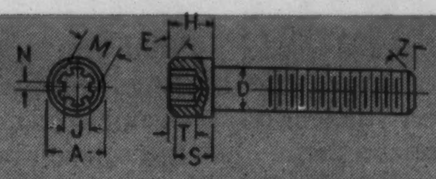


Table 6—Fluted Socket Head Cap Screws

	D		A		H		N	
Nominal Size	Body Diameter		Head Diameter[1]		Head Height[2]		Width of Socket Land	
	Max	Min	Max	Min	Max	Min	Max	Min
2	0.0860	0.0840	0.140	0.136	0.086	0.083	0.016	0.015
3	0.0990	0.0968	0.161	0.157	0.099	0.096	0.022	0.021
4	0.1120	0.1096	0.183	0.178	0.112	0.109	0.022	0.021
5	0.1250	0.1226	0.205	0.200	0.125	0.122	0.025	0.023
6	0.1380	0.1353	0.226	0.211	0.138	0.134	0.025	0.023
8	0.1640	0.1613	0.270	0.265	0.164	0.160	0.032	0.030
10	0.1900	0.1867	5/16	0.306	0.190	0.185	0.039	0.037
12	0.2160	0.2127	11/32	0.337	0.216	0.211	0.039	0.037
1/4	0.2500	0.2464	3/8	0.367	1/4	0.244	0.050	0.048
5/16	0.3125	0.3084	7/16	0.429	5/16	0.306	0.060	0.058
3/8	0.3750	0.3705	9/16	0.553	3/8	0.368	0.092	0.089
7/16	0.4375	0.4326	5/8	0.615	7/16	0.430	0.092	0.089
1/2	0.5000	0.4948	3/4	0.739	1/2	0.492	0.112	0.109
9/16	0.5625	0.5569	13/16	0.801	9/16	0.554	0.112	0.109
5/8	0.6250	0.6191	7/8	0.863	5/8	0.616	0.138	0.134
3/4	0.7500	0.7436	1	0.987	3/4	0.741	0.149	0.145
7/8	0.8750	0.8680	1 1/8	1.111	7/8	0.865	0.168	0.164
1	1.0000	0.9924	1 5/16	1.297	1	0.989	0.189	0.185

	S			J		M	
Nominal Size	Head Side-Height[2]			Socket[3] Diameter Minor		Socket[3] Diameter Major	
	Nom	Max	Min	Max	Min	Max	Min
2	0.0788	0.0803	0.0773	0.064	0.063	0.074	0.073
3	0.0907	0.0923	0.0891	0.082	0.080	0.098	0.097
4	0.1026	0.1043	0.1009	0.082	0.080	0.098	0.097
5	0.1146	0.1163	0.1129	0.098	0.096	0.115	0.113
6	0.1265	0.1284	0.1246	0.098	0.096	0.115	0.113
8	0.1503	0.1522	0.1484	0.128	0.126	0.149	0.147
10	0.1741	0.1765	0.1717	0.163	0.161	0.188	0.186
12	0.1980	0.2005	0.1957	0.163	0.161	0.188	0.186
1/4	0.2291	0.2317	0.2265	0.190	0.188	0.221	0.219
5/16	0.2864	0.2894	0.2834	0.221	0.219	0.256	0.254
3/8	0.3437	0.3469	0.3405	0.319	0.316	0.380	0.377
7/16	0.4010	0.4046	0.3974	0.319	0.316	0.380	0.377
1/2	0.4583	0.4620	0.4546	0.386	0.383	0.463	0.460
9/16	0.5156	0.5196	0.5116	0.386	0.383	0.463	0.460
5/8	0.5729	0.5771	0.5687	0.509	0.506	0.604	0.601
3/4	0.6875	0.6920	0.6830	0.535	0.531	0.631	0.627
7/8	0.8020	0.8069	0.7971	0.604	0.600	0.709	0.705
1	0.9166	0.9220	0.9112	0.685	0.681	0.801	0.797

[1] *CONCENTRICITY of head, body and thread shall be such as to permit acceptance when checked with a compound go gage, which will gage the maximum diameters of these three parts simultaneously. This gage shall have the head and body diameters at their maximum values but expressed to four decimal places and the pitch diameter at the maximum value allowed for Class 3, NC and Class 3, NF American Standard Screw Threads. (B1, 1)*

[2] *HEAD CHAMFER (E). The head shall be chamfered. The flat shall be normal to the axis of the screw and the chamfer (E) shall be at an angle of 30 ± 2 with the surface of the flat. The edge between flat and chamfer shall be slightly rounded.*

[3] *SOCKET DEPTH (T). Maximum socket depth (T) should not exceed three-fourths of minimum head height (H).*

and 5) are narrower. The closest tolerances are held on fluted socket head screws (Table 6). In each case, the tolerances on every dimension increase with the size of the part.

Tolerances in cold heading depend on die and punch wear. On shank diameters, for example, limits of ±0.001 in. can be held if necessary, but ±0.002 in. is more reasonable. Cutting the tolerance from ±0.002 to ±0.001 in. reduces die life from 50 to 95% with the same part design and corner fillets. Similar reductions in die life (and similar cost increases) result from decreasing tolerances on other part dimensions.

A good commercial tolerance on shank diameters is ±0.003 in., although there may be some distortion of longitudinal shank straightness beyond these limits with long, slender parts that are annealed. Most of the head dimensions—the head diameter, the distance between head side flats, the head height, etc.—can carry ±0.005 in., although this varies with the size of the head. Tolerances on the overall length of a piece are wider. Final length is fixed by the cutoff length of the blank. A generous commercial tolerance on the overall length of a part is ±1/32 in., although this dimension can be held closer if necessary. Tolerances of ±1/32 in. should be given on the length of a part with upsets on both ends.

Consulting the Manufacturer

Final tolerances, head shapes and the materials for a cold headed part should not be decided upon without consulting the parts manufacturer. If the manufacturer is told the loading on the part and shown a sketch of the mating parts, he can often suggest design changes or tolerance variations to facilitate production without affecting performance. When the manufacturer understands the application of the part, he can often vary manufacturing methods or suggest changes in the material which will increase part reliability or performance.

The parts manufacturer can help in other ways. With careful design, cold heading can also be used, in some cases, with comparatively short run parts. Certain modifications of standard parts can be made by the manufacturer without using new dies and punches. The shape of the head or any portion of the part that is formed by the die surfaces cannot be changed, but the shank length can often be varied by changing the knockout pin, and the size of a flat head can be varied by changing the length of the wire blank. The parts manufacturer is the only source of information on short cuts like these.

Acknowledgments

The following organizations, through their literature and personal help, assisted in the preparation of this Manual. Tables 2, 3, 4, 5 and 6 adapted from Standards published by the ASME.

Alloy Metal Wire Co., Inc.
American Steel & Wire Co.
Aluminum Co. of America
Bethlehem Steel Co., Inc.
Bridgeport Brass Co.
Carpenter Steel Co.
Champion Rivet Co.
Chase Brass & Copper Co.
Cleveland Cap Screw Co.
Hartford Machine Screw Co., Inc.
Industrial Fasteners Institute
International Nickel Co., Inc.
John Hassal, Inc.
National Machinery Co.
Reynolds Metals Co.
Scovill Manufacturing Co.
Townsend Co.
Titanium Metals Corp.

How to Submit an Inquiry

Data	Purpose
Description of part Part number Dimensions	
Allowable tolerances for each dimension	If maximum allowable is indicated on first inquiry, subsequent correspondence may be eliminated, or extra charges for tolerances may be saved.
Material	If sample only is submitted, it must often be routed to the metallurgical department for analysis, delaying quotation.
Heat treatment	
Finish	Type and minimum depth if plated.
Drawing enclosed	
Sample enclosed	Often the submitted sample, which is proving satisfactory to the customer in actual production, is not in strict conformity to the original drawing. The sample will reveal any permissible departures from the drawing that may be necessary in heading the part.
How made previously	If no sample is submitted, previous method may indicate departures from drawing or suggest problems the customer may encounter if part was not previously headed.
When shipment must be made	Approximate shipping time as indicated by production backlog will normally be given. If early shipment is required, however, production schedules can be specially checked for possible rearrangements, or partial shipments may be promised.
Quantities on which to quote	Price varies with quantity. Customer should indicate the various quantities he might buy to get prices on each.
Approximate annual requirements	If part is new or experimental, so that quantities to be quoted on are not indicative of eventual requirements, this information tells estimator how far to go in exploring special manufacturing possibilities of the part.
What part is used for and what it does	May enable engineer to make helpful suggestions.

The more information the estimators of the cold headed parts manufacturer have in processing an inquiry, the more intelligently they can quote or recommend design changes. While it is not always necessary to supply all the data covered by the check list above, no quotation will be delayed for lack of information if all these facts are given.

Courtesy The Towsend Co.

Materials & Methods

Materials Engineering File Facts

NUMBER 217
November, 1951

MATERIALS DATA SHEET

High Carbon Steels

Steels in this group are used for certain hand tools, agricultural machinery, heavy machine parts, and springs. For most applications, they are heat treated. They can be hardened by quenching in oil for general purposes or by quenching in water or brine for cutting edges.

Typical Properties

AISI Type	C1055	C1060	C1070	C1080	C1095
COMPOSITION, %	C, 0.50–0.60 Mn, 0.60–0.90 P max, 0.040 S max, 0.050	C, 0.55–0.65 Mn, 0.60–0.90 P max, 0.040 S max, 0.050	C, 0.65–0.75 Mn, 0.60–0.90 P max, 0.040 S max, 0.050	C, 0.75–0.88 Mn, 0.60–0.90 P max, 0.040 S max, 0.050	C, 0.90–1.05 Mn, 0.30–0.50 P max, 0.040 S max, 0.050
PHYSICAL PROPERTIES					
Density, Lb/Cu In.	0.283	0.283	0.283	0.283	0.283
Thermal Cond, Btu/Hr/Sq Ft/Ft/F @ 212 F	27	27	27	27	27
Coeff of Exp per F: 70-1200	8.1×10^{-6}	8.1×10^{-6}	8.1×10^{-6}	8.1×10^{-6}	8.1×10^{-6}
Spec Ht, Btu/Lb/F	0.10–0.11	0.10–0.11	0.10–0.11	0.10–0.11	0.10–0.11
Elect Res, Microhm-Cm @ 68 F	18	18	18	18	18
Magnetic Properties	Magnetic	Magnetic	Magnetic	Magnetic	Magnetic
MECHANICAL PROPERTIES					
Mod of Elast in Tension, Psi	$29–30 \times 10^6$	$29–30 \times 10^6$	$29–30 \times 10^6$	$29–30 \times 10^6$	$29–30 \times 10^6$
Tensile Str, 1000 Psi:					
Annealed 1450 F	97	105	112	119	100
Hot Rolled	109	116	128	141	142
Hard & Temp	150 (a)	160 (b)	174 (c)	189 (d)	180 (e)
Yield, 1000 Psi:					
Annealed	52	54	60	66	53
Hot Rolled	65	70	77	84	84
Hard & Temp	105	112	127	142	118
Elong in 2 In., %:					
Annealed	24	20	17	15	21
Hot Rolled	19	17	15	12	9
Hard & Temp	14	12	13	14	11
Reduction of Area, %:					
Annealed	47	44	34	22	42
Hot Rolled	38	36	27	17	18
Hard & Temp	45	40	37	34	30
Hardness, Bhn:					
Annealed	185	192	207	223	197
Hot Rolled	235	241	267	293	293
Hard & Temp	307	321	354	388	375
Impact Str, Izod, Ft-Lb:					
Annealed	22	15	11	6	5
Hot Rolled	18	13	9	5	3
Hard & Temp	22	15	13	10	5
THERMAL TREATMENT					
Normalizing Temp, F	1525–1650	1525–1650	1525–1650	1525–1650	1525–1650
Annealing Temp, F	1500–1575	1500–1575	1500–1575	1500–1575	1500–1575
Hardening Temp, F	1450–1550	1450–1550	1450–1525	1450–1500	1430–1500
Tempering Temp, F	400–1300	400–1300	400–1300	400–1300	400–1300
FABRICATING PROPERTIES					
Hot Working Temp Range, F	1550–1650	1550–1650	1550–1650	1550–1650	1550–1650
Machinability Index (B1112 Steel = 100) Annealed	55	53	45	44	43
Weldability	The high carbon content of these steels introduces difficulties in welding. These steels can be welded satisfactorily by the thermit process. Welding by the gas and arc methods is difficult and the resulting welds are only moderately satisfactory.				
CORROSION RESISTANCE	The carbon steels rust when brought into contact with moisture and air at room temperature at rates which are not appreciably affected by the carbon content. If salts are present, the corrosion rate is increased. These steels are attacked readily by acids but are resistant to alkalies at ordinary temperatures.				
AVAILABLE FORMS	These steels are furnished in the form of cold-rolled strip, hot-rolled strip, and flat bars and forgings.				
USES	Typical uses include heavy machine parts, such as shafts, braces and control rods; hand tools, including open-end and Stillson wrenches, hammers, pliers, screw-drivers, hatchets and axes; agricultural machinery parts, such as plow-shares, mold boards, disks for harrows, and mower knives; small cold-formed flat springs, large hot-formed flat springs, and hot coiled helical springs.				

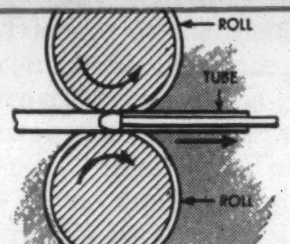
NOTES: *(a) 1 in. round, normalized 1650 F, reheated to 1550 F, oil quenched, tempered 700 F.*
(b) 1 in. round, normalized 1650 F, reheated to 1550 F, oil quenched, tempered 700 F.
(c) 1 in. round, normalized 1650 F, reheated to 1525 F, oil quenched, tempered 700 F.
(d) 1 in. round, normalized 1650 F, reheated to 1525 F, oil quenched, tempered 700 F.
(e) 1 in. round, normalized 1650 F, reheated to 1475 F, oil quenched, tempered 700 F.

let's take a CLOSER LOOK at

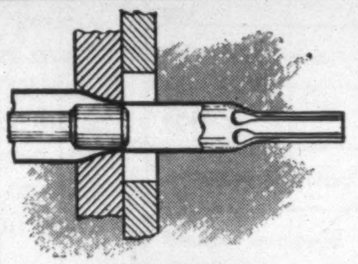
Surface Finishes

If you machine or fabricate hollow parts from tubing, chances are you have one or more *finishing* problems. Perhaps you can *start* finishing right in your own purchasing department by specifying the type of mill-finish best . . . and most economically . . . suited to your end-use requirements.

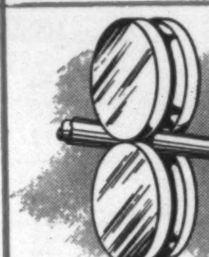
As a specialty tube mill, B&W can supply mechanical tubing with any of the following finishes — as an integral part of the manufacturing process:



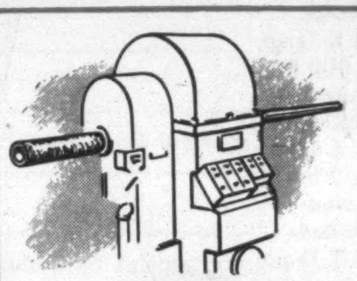
HOT-FINISHED
bears the scale formed during hot fabrication or heat treatment.



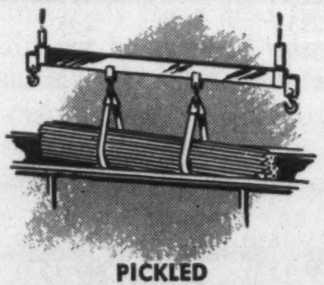
COLD-DRAWN
smooth, scale-free surface.



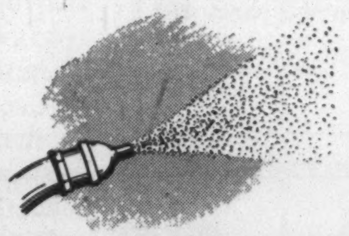
ROCKED
smooth surfaces, obtained by special sizing and finishing process.



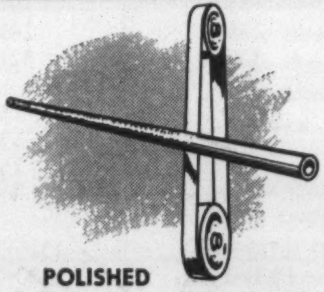
TURNED
machined, uniform O.D.



PICKLED
de-scaled by one of several solutions.

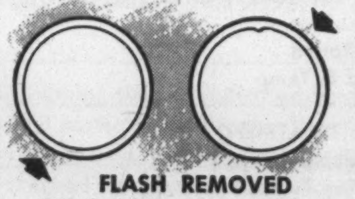


SHOT- OR SAND-BLASTED
O.D. and/or I.D. scale is removed by blasting.



POLISHED
O.D. and/or I.D. polished to one of several specified degrees of smoothness.

FLASH-IN
ERW tubing which retains the bead formed by welding.



FLASH REMOVED
ERW tubing, bead - free.
Both available either as welded or normalized.

Remember—tubing is not just bar-stock with a hole in it, but a semi-finished product, having a wide range of optional finishes, tolerances, chemical and mechanical properties. Ask Mr. Tubes — your B&W Tube Company representative — to help you select the tubing best suited to your particular applications.

B&W
SEAMLESS and WELDED
TUBES

THE BABCOCK & WILCOX TUBE COMPANY
Executive Offices: Beaver Falls, Pa.
General Offices & Plants
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

Sales Offices: **Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. • Cleveland 14, Ohio • Denver 1, Colo. Detroit 26, Mich. • Houston 2, Texas • Los Angeles 15, Calif. • New York 16, N. Y. • Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Calif. • Syracuse 2, N. Y. • Toronto, Ontario • Tulsa 3, Okla.**

TA-1639M

Materials & Methods

Materials Engineering File Facts

NUMBER 218
November, 1951

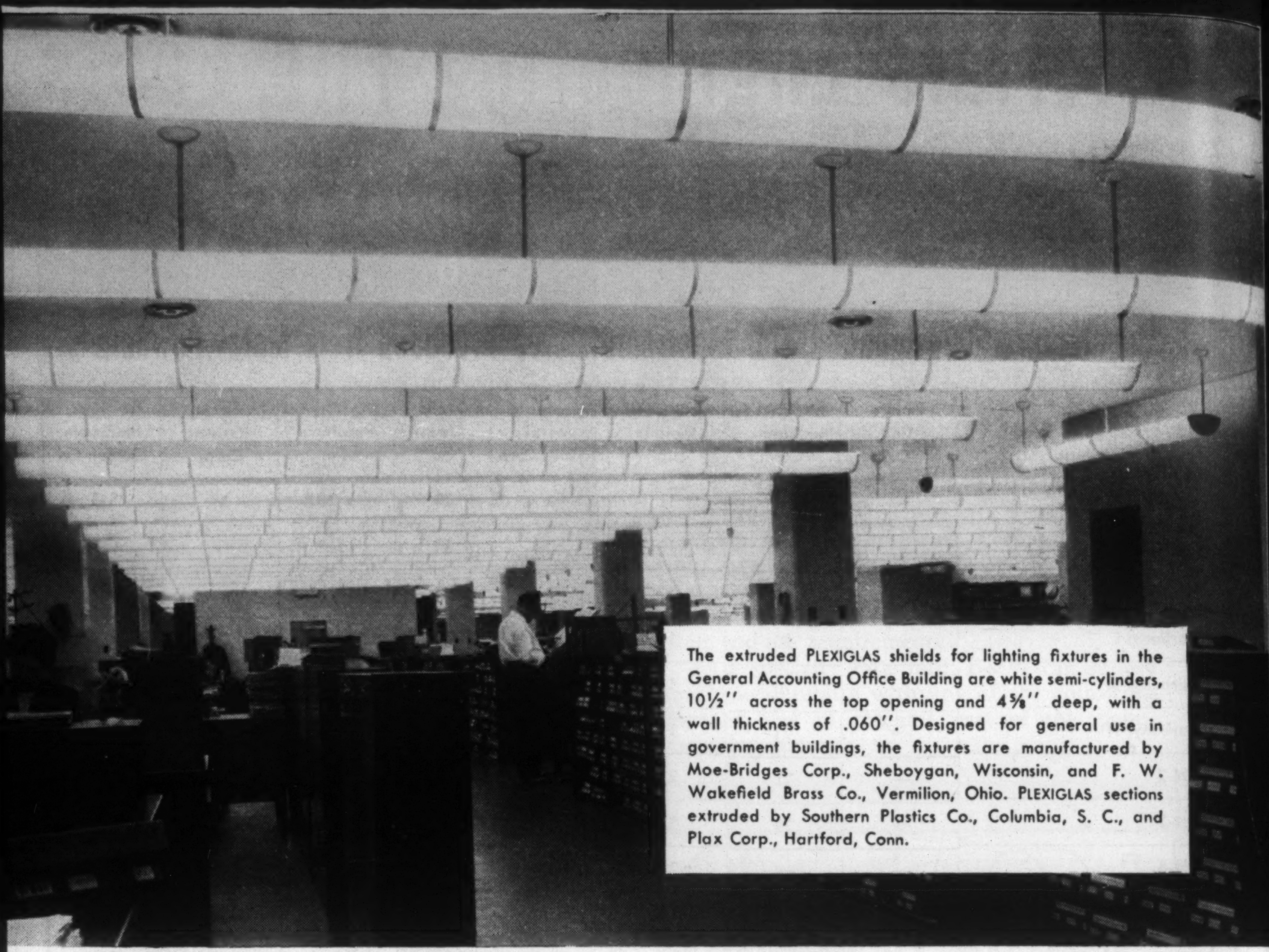
MATERIALS Metal Powders

Manufacturers Designations for Electronic Cores Produced from Metal Powders

Basic Material	Empire Coil Co.	Magnetic Core Corp.	National Moldite Co.	Powdered Metal Products Corp.	Radio Cores Inc.	Pyroferric Co.	Speer Resistor Corp.	Stackpole Carbon Co.
Carbonyl C	—	85	11	E6	21	PY 2RA	M	S52
Carbonyl E	—	25	17	E5	10	PYI A	G	G1
Carbonyl HP	—	90	37	E22	20	PY 17A	Z	S62
Carbonyl L	—	80	10	E11	24	PY 3RA	F	S53
Carbonyl SF	—	76	14	E10	12	PY 13A	N	G5
Carbonyl TH	—	73	13	E33	11	PY 14A	E	G2
IRN-2	—	71	23	E23	2	PY 4A	LL-2	C26
IRN-3	—	79	31	E34	3	—	LL-3	S54
IRN-6	—	—	29	E35	—	—	LL-6	—
IRN-8	—	74	19	E14	8	PY 12A	U	GY8
IRN-9	—	74-B	41	E12	9	PY 11A	LL-9	GY9
IRN-16	—	—	30	E16	16	PY 20A	LL-16	—
IRN-31	—	71-B	—	—	—	PY 3A	—	—
Plast-Sponge C3H-BG30	—	—	44	E36	4	PY 15S	D	X29
Plast-Sponge C1C-A30	E1	91	—	E37	25	—	—	—
Plast-Sponge C3H-A30	—	—	—	—	—	—	D	—
Plast-Coriron KIJ-A33	E2	92	42	E19	22	PY 15X	—	—
Plast-Iron A3G-G10	—	—	—	E3	23	PY 22A	—	S49
Plast-Iron A3G-A10	—	—	—	—	—	—	A	—
Plast-Iron A2B-A10	—	—	—	—	—	—	L	—
Plast-Iron Flakes M17K-A16	—	—	48	E32	26	GRN	—	—
Magna-Tite A	—	—	A15	E8	—	—	—	—
Magna-Tite C	—	77	C15	—	—	—	—	—
Magna-Tite H	—	78	H15	—	—	—	—	—
Magnetites	—	—	—	—	30	PY 5A to PY 9A	—	Y Grades

NOTE: Cores made from basic raw materials by different core manufacturers are not necessarily interchangeable. It is advisable, in order to obtain identical characteristics, that mutual standards be agreed upon. The designations as given are basic and can be modified by the manufacturer to indicate variations in formula, such as type and amount of insulation and binder.

Courtesy Metal Powder Association



The extruded PLEXIGLAS shields for lighting fixtures in the General Accounting Office Building are white semi-cylinders, 10½″ across the top opening and 4⅝″ deep, with a wall thickness of .060″. Designed for general use in government buildings, the fixtures are manufactured by Moe-Bridges Corp., Sheboygan, Wisconsin, and F. W. Wakefield Brass Co., Vermilion, Ohio. PLEXIGLAS sections extruded by Southern Plastics Co., Columbia, S. C., and Plax Corp., Hartford, Conn.

25 Miles of

EXTRUDED PLEXIGLAS

At the new General Accounting Office Building in Washington, twenty-five miles of PLEXIGLAS acrylic plastic shields are used to reflect and transmit light from nearly thirty-three thousand fluorescent fixtures. Extrusion-grade PLEXIGLAS made possible the most economical production of shields that would meet the rigid requirements of the application—dimensional stability, resistance to discoloration and breakage, and control of the transmittance-reflectance ratio.

For *your* large volume applications requiring extruded parts, consider PLEXIGLAS. Extrusion-grade PLEXIGLAS molding powders are being used for a wide variety of shapes—curved panels, tubes, rods, and flat and corrugated sheets. Such sections have the familiar PLEXIGLAS properties of light weight, durability, dimensional and color stability, and resistance to age and weather.

For information on clear and colored PLEXIGLAS powders for injection and extrusion molding, write for our technical bulletins. We'll be glad to send you full details.

CHEMICALS FOR INDUSTRY

PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.*

Canadian Distributor: *Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.*

ROHM & HAAS
COMPANY
WASHINGTON SQUARE, PHILADELPHIA 5, PA.
Representatives in principal foreign countries

New Materials and Equipment

New Method of Rust Prevention Uses Rust-Inhibiting Paper

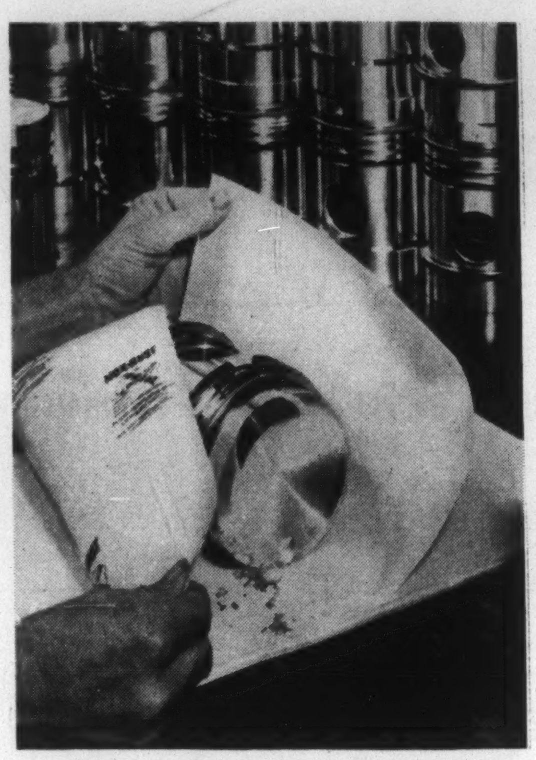
A method of rust prevention that involves use of volatile, rust-inhibiting paper has been developed by *Nox-Rust Chemical Corp.,* Chicago.

The paper, which protects metal from rust by making moisture noncorrosive, is impregnated with Callex, a synthetic chemical, and is wrapped around products being stored or shipped or is used as a liner inside crates and packages. If moisture enters the crate, the chemical volatilizes and completely surrounds the metal, thus activating the moisture. The chemical reacts according to the amount of moisture; if the air in the package is dry, there is no volatile action. It is not necessary for the metal to touch the paper and the package does not have to be tightly sealed.

Advantages claimed for the new method are: saves labor costs by eliminating the need for removal of grease at the receiving point; less expensive than older, greasy coatings; requires no cleaning after the wrapper is removed; the paper's chemical action remains effective for many years; and Vapor Wrapper can be re-used.

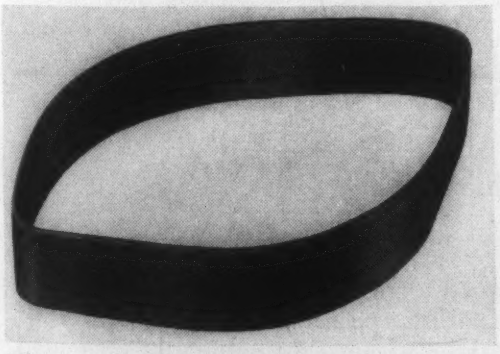
Several grades of this new product have been developed, some made with single ply kraft sheets, others laminated for extra protection. The newest of these is made of two tough kraft sheets laminated with glass fibers and a bonding material, for use with bulky, heavy equipment.

According to the manufacturer, the new rust-preventative paper is being used by a wide variety of industries. Products being protected with it include: steel bars and rods; bearings; gears; machine tools; tractor and implement parts; aircraft engine parts; business calculating machines; valves and pistons. The wrappers are also proving their value in the rearmament effort, not only in defense production, but in use by the armed forces where they protect small arms and a large variety of weapons, parts and other equipment from corrosion.



Packaging and rust-prevention is combined by use of volatile, corrosion-inhibiting paper.

Magnetic Recording Rubber Has Neoprene Base



This band is fabricated from a special recording magnetic rubber made from a Neoprene base.

The Brush Development Co., 3405 Perkins Ave., Cleveland 14, has announced a new magnetic recording rubber made from a special Neoprene base. The highly efficient magnetic oxide has been pigmented into the Neoprene with an unusually good degree of uniformity, according to the manufacturer. Also included in the base material is a permanent lubricant which is said to virtually eliminate wear of both medium and associated recording head. Mechanical compliance of the medium provides for intimate contact with the recording head.

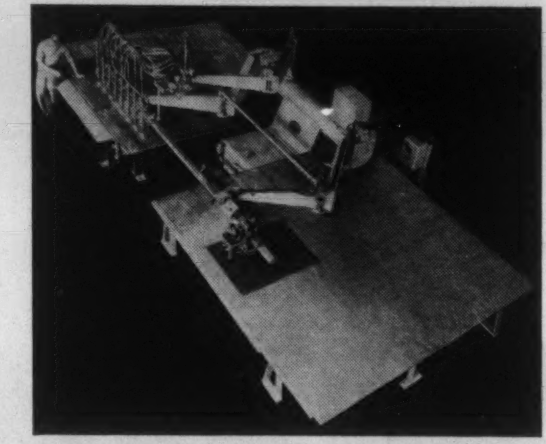
Primarily designed for use when stretched over a supporting drum, the recording bands can be supplied on special order in a variety of sizes and shapes that will be able to meet every individual requirement.

Paint Heater Designed for Hot Spray Finishing

Designed exclusively for hot spray technique in applying all types of protective coatings, such as lacquers, enamels, varnishes, paints, priming and surface compounds, a new low cost, tandem type paint heater is currently being offered by *Dualheet, Inc.,* 10118 Detroit Ave., Cleveland 2.

According to the manufacturer, the heater introduces advanced features of design and utility, such as single or tandem installations either mounted on the wall or equipped with casters for moving. Tandem installations can be gauged together in one jacket so that several colors are available at proper temperature at all times. Lightweight—only 5 in. sq. and 19 in. long—each unit weighs only 28 lb. without material circulating system. Elimination of needless bulk and weight permits lower cost and allows desired portability. The unit, approved by Underwriter Laboratories for use in Class I, Group D hazardous locations, is cast aluminum throughout.

Among the many advantages to users of the units are: improved quality of finish; fewer coats needed; labor savings; reduced rubbing and polishing; absence of blushing troubles; and heavier coatings.



This cutting machine is said to cut an unlimited variety of shapes from steel plates, slabs, billets and forgings.

Heavy Duty Pantograph Type Cutting Machine

Airco No. 50 Travograph, the latest addition to its line of gas cutting machines, has been announced by *Air Reduction Sales Co.,* a division of *Air Reduction Co., Inc.,* 60 E. 42 St., New York 17. A development of many years of research, the new heavy duty pantograph type cutting machine is said to cut an unlimited variety of shapes from steel plates, slabs, billets and forgings and make equally practicable and economical the cutting of either one or a few parts or identical parts on a quantity production basis.

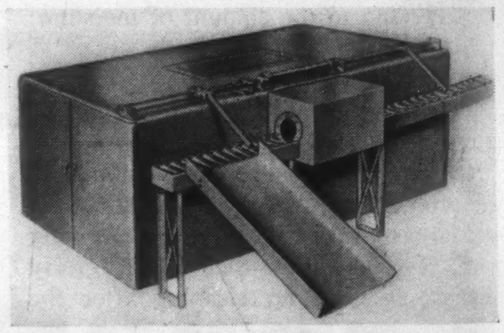
All welded, heavy gage steel construction gives this machine its strength. The rigid rail assembly, made of specially rolled tracks with accurately machined surfaces, provides a smooth runway for the carriage. Guide rollers on the carriage base keep the carriage on a true, vibration-free course.

Induction Furnace Provides Uniformity of Heating

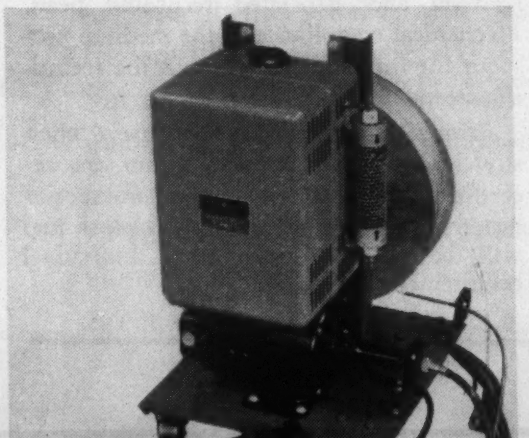
Currently being offered by *Loftus Engineering Corp.,* 610 Smithfield St., Pittsburgh, is a new 60-cycle induction furnace for the heating of nonferrous metals and some applications of steel. The furnace is said to provide absolute uniformity of heating and at the same time assure balanced electrical loading from a three-phase line.

The patented process involves a transformer which converts balanced three-phase power into two-phase operation. Two closely interlaced coils leading off this two-phase line surrounds the billet and provides all the characteristics of uniformity and through penetration of single-phase heating. Large eddy currents are caused to flow in the billet to be heated, insuring fast, clean, absolutely uniform heating for forging, extrusion and rolling. With this method, the three-phase power line is said to be constantly in balance.

The furnace itself is built to the customer's specification and is designed for any size or shape of billet, and can be equipped with as many coil units as are necessary to meet production requirements. The new unit is also claimed to be ideal for shrinking steel, such as permanently attached steel jackets to steel shafts.



This 60-cycle induction furnace is for heating nonferrous metals.



This unit, consisting of a gun and mechanical power unit, is designed to speed alloy-metal welding.

Welding Attachment Speeds Alloy-Metal Welding

Fillerweld, a new product designed to speed alloy-metal welding on applications where filler-metal must be added, has been announced by the Welding Dept., *General Electric Co.,* Schenectady, N. Y.

Used with gas-shielded arc welders, the unit allows the operator to control the continuous flow of filler-metal automatically by means of a finger switch mount on the torch. According to company engineers, the attachment permits the operator to start or stop the flow of filler metal without breaking the arc, resulting in a smoother, faster weld. Wide application is expected for the product on food and dairy equipment and in the fabrication of aluminum containers and light structural shapes.

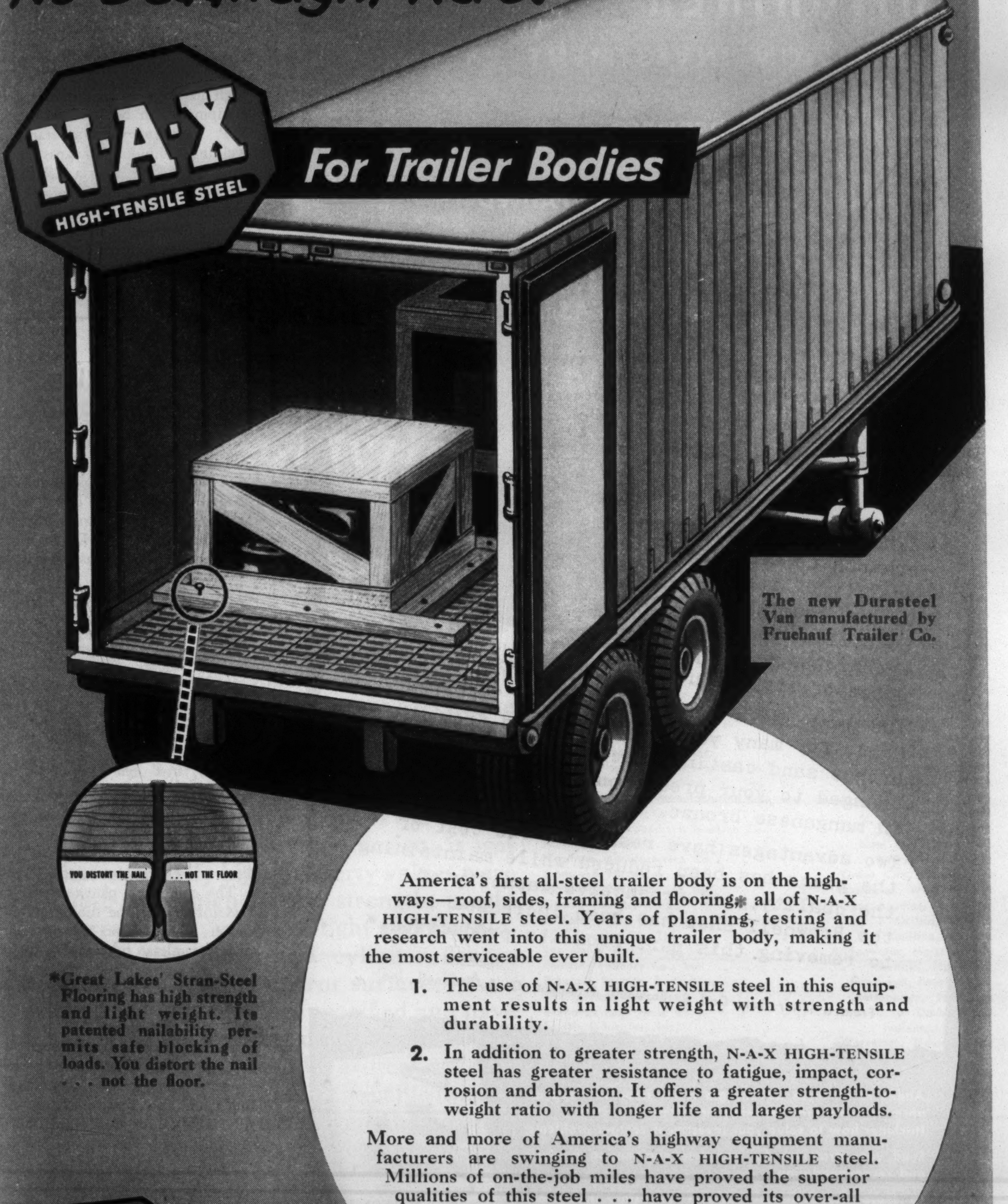
Fillerweld consists of two main elements —the torch or gun, and a mechanical power unit. The gun is basically a manual water cooled Inert-Arc tungsten holder to which has been added a control switch, and a gear assembly for pulling the filler-metal from the spool to the arc through the gun. Rated at 250 amp, the gun accommodates tungsten from 0.040 to 5/32 in. in dia and up to 7 in. long.

The mechanical power unit consists of a motor which provides the power for drawing the filler-metal, a Thy-mo-trol unit for controlling the motor, and a spool which holds the filler wire. This unit is mounted on a portable platform and can be moved easily from job to job.

Operation of the unit is said to be easy. The process can be applied to best advantage on stock less than 3/16 in. thick. However, where speed is not of paramount consideration, Fillerweld will produce a

(Continued on page 108)

No Deadweight Here!



The new Durasteel Van manufactured by Fruehauf Trailer Co.

*Great Lakes' Stran-Steel Flooring has high strength and light weight. Its patented nailability permits safe blocking of loads. You distort the nail . . . not the floor.

America's first all-steel trailer body is on the highways—roof, sides, framing and flooring,* all of N-A-X HIGH-TENSILE steel. Years of planning, testing and research went into this unique trailer body, making it the most serviceable ever built.

1. The use of N-A-X HIGH-TENSILE steel in this equipment results in light weight with strength and durability.
2. In addition to greater strength, N-A-X HIGH-TENSILE steel has greater resistance to fatigue, impact, corrosion and abrasion. It offers a greater strength-to-weight ratio with longer life and larger payloads.

More and more of America's highway equipment manufacturers are swinging to N-A-X HIGH-TENSILE steel. Millions of on-the-job miles have proved the superior qualities of this steel . . . have proved its over-all economy.

GREAT LAKES STEEL CORPORATION
N-A-X Division • Ecorse, Detroit 29, Michigan

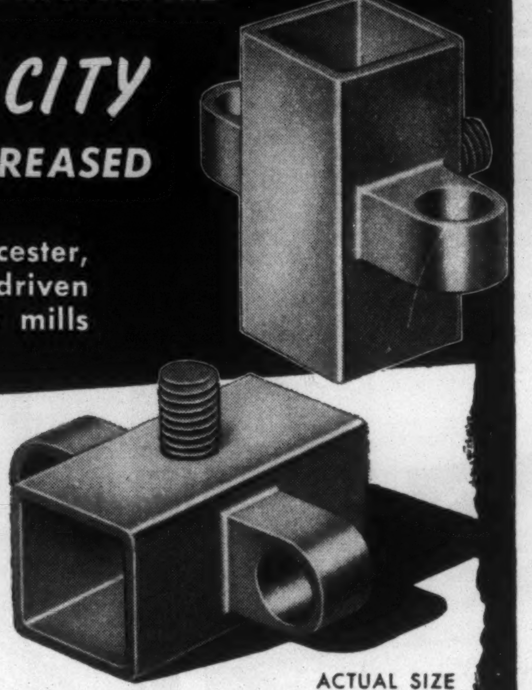
NATIONAL STEEL CORPORATION

It's your
SCRAP
that makes your
STEEL
Keep it moving to your scrap dealer

WITH
HITCHINER
PRECISION INVESTMENT CASTINGS

COST IS REDUCED
QUALITY IS MAINTAINED
PLANT CAPACITY IS INCREASED

for G. L. Brownell, Inc., Worcester, Mass., manufacturer of gear driven twisting machinery for textile mills since 1881.



"This company is always anxious to keep the quality of its product up but equally desirous to utilize any new techniques to keep the price of its product as low as possible.

The part shown above, known as a Traverse Head, for many years was machined from a bronze sand casting. Recently this part was changed to your precision investment casting in manganese bronze.

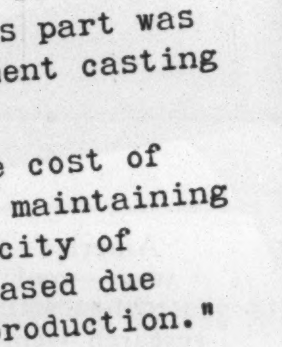
Two advantages have resulted. The cost of the piece has been reduced while maintaining the quality, and productive capacity of the Brownell shop has been increased due to removing this part from its production."

From a letter from Carl R. Brownell, President, G. L. Brownell, Inc.

Added to all these advantages is the improved appearance inherent in precision investment castings. Ask Hitchiner how to solve your investment casting problems.

Send your drawings for complete engineering analysis and recommendation.

To learn more about Hitchiner precision investment castings send for this free informative folder.


There is one RIGHT WAY to form these parts...
HITCHINER
PRECISION INVESTMENT CASTINGS

HITCHINER Manufacturing Company, Inc.
MILFORD 3, NEW HAMPSHIRE
Sales Office: 967 Farmington Ave., West Hartford 7, Ct. Representatives in principal cities.

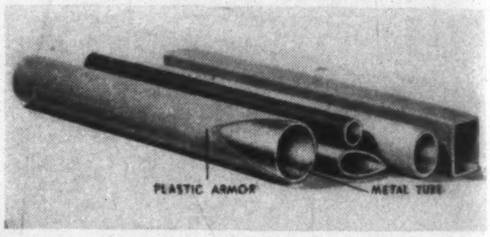
New Materials and Equipment

high quality weld on thicker material. The equipment can be used with a GE type WP Inert-Arc welding transformer for welding aluminum, magnesium or beryllium copper; or with a GE WD-4150 or WD-4200 for welding stainless steel, copper, Inconel steel and other weldable alloys. Either argon or helium can be used with the equipment.

Tubing Offered in Large Variety of Sizes, Colors and Finishes

Samuel Moore & Co., Mantua, Ohio, has announced the addition of square, triangular, oval and streamlined shapes to its line of standard round tubing.

Made in a large variety of sizes, colors and finishes, the new Dekoron tubing can be used in many industrial and consumer applications, such as in furniture, appliances, garment rails, grab rails and stanchions in transit vehicles, sporting goods, automotive parts, industrial instrument lines and electrical conduit.



This tubing is offered in square, triangular, oval and streamlined shapes.

The company's patented extrusion process for coating the tubing permits application of vinyl or polyethylene plastic over seamless tubing or tubing with welded, lap or butt seams. It can be applied over any kind of metal core.

According to the manufacturer, the tubing will not crack, chip, peel or flake. It resists corrosion from salt air, moisture, oils, acids and alkalies, and is unaffected by normal temperature changes. Warm to touch and free from static electric shock, the tubing can be given any desired dielectric properties.

Improved Tumbling Compound for Ferrous Metals

A new addition to the line of tumbling equipment, compounds and techniques that comprise Tumb-L-Matic processes for metal and plastics finishing is Tumb-L-

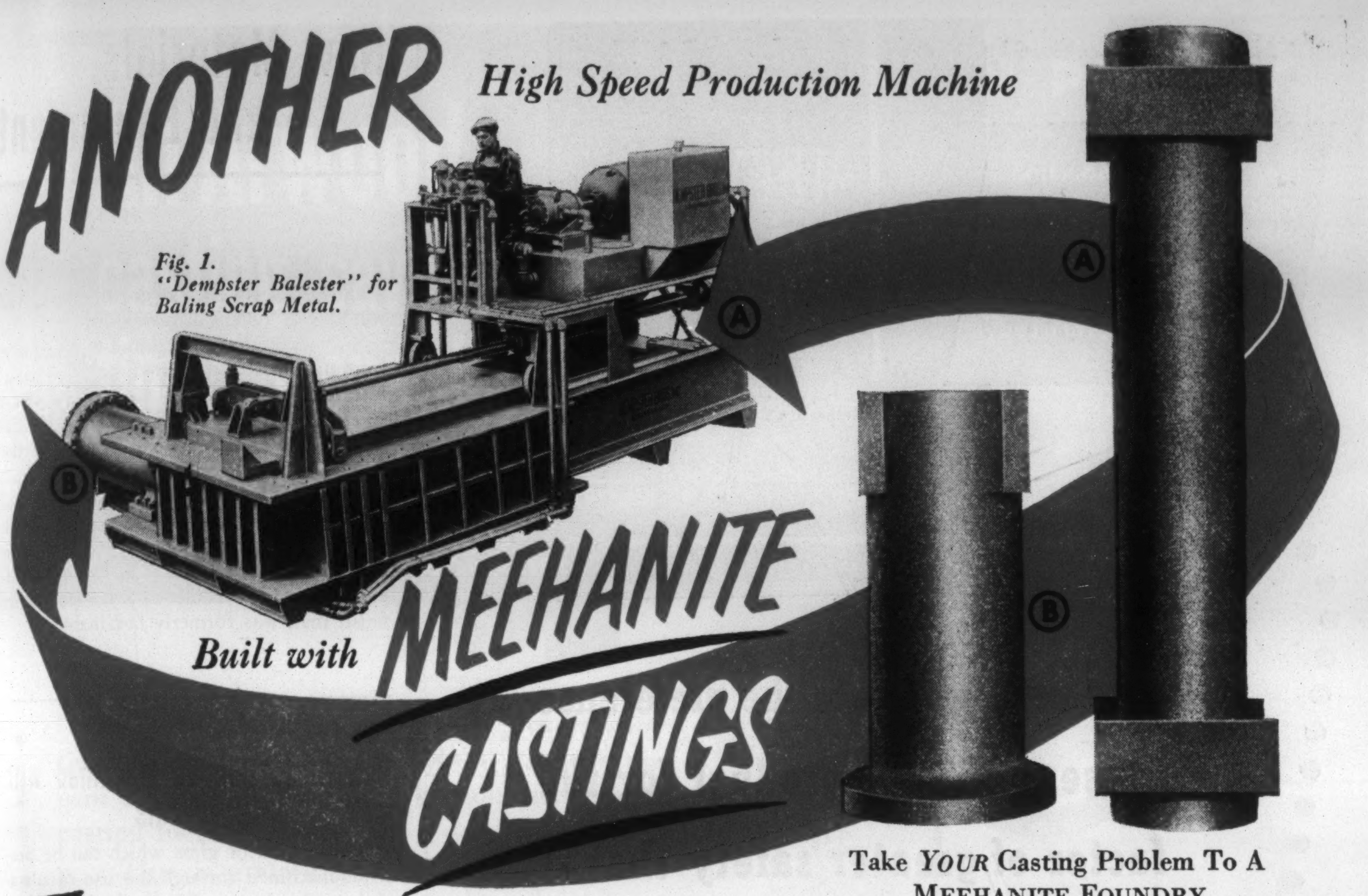


Fig. 1.
"Dempster Balester" for
Baling Scrap Metal.

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

The equipment (Fig. 1) known as the "Dempster Balester", built by Dempster Brothers, Inc., Knoxville, Tennessee, is setting production records in its function of baling scrap metals into heavy, high density bales. Built into this machine are Meehanite castings which take the full force of the compressive mechanism. These are: Ⓐ Main Gathering Ram Cylinder; Ⓑ Side Compression Cylinder.

In analyzing the requirements of the double acting cylinders demanded by the design, it was apparent that unusually high property values were needed. These were high tensile strength, toughness; a uniform, dense, pressure-tight and machinable structure. Also bores and cylinder flanges needed an extremely fine "mirror surface." As a result, Meehanite castings were specified and have provided all these engineering characteristics.

If you today are harassed by critical material and alloy shortages and it seems impossible to meet your quality specifications, investigate the possibility of Meehanite castings solving your problems.

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

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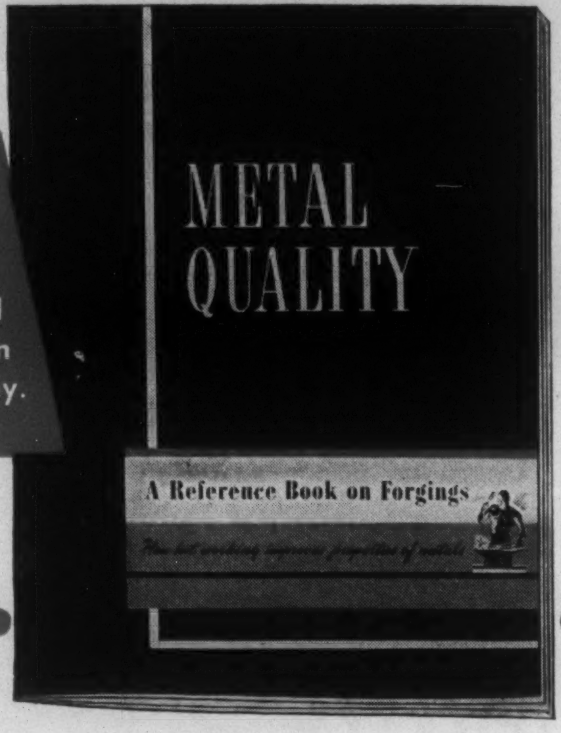


Engineering, production and economic advantages obtainable with forgings are presented in this Reference Book on forgings. Write for a copy.

Never underestimate the preference of users of your product for the factor of greater safety that is inherent in forgings. This factor of greater safety results from toughness and strength, in correct proportion, as found only in closed die forgings. Consult a forging engineer about the mechanical properties required for your product.

DROP FORGING ASSOCIATION
605 HANNA BLDG. • CLEVELAND 15, OHIO

Please send 60-page booklet entitled "Metal Quality — How Hot Working Improves Properties of Metal", 1949 Edition.

Name ....
Position ....
Company ....
Address ....

New Materials and Equipment

Magic, said to be a greatly improved wet-process tumbling compound.

The special properties of this new formulation are attributed by the manufacturer, *Tumb-L-Matic, Inc.*, 4510 Bullard Ave., New York 70, to the greater abrasive action of the media because of the chemical cleaning action of the product. The cleaner acts to suspend grease and cuttings in the solution, thus keeping work surfaces and abrasive media free of action-retarding accumulations. Use of the compound is said to result in a faster, higher finish than was formerly obtainable.

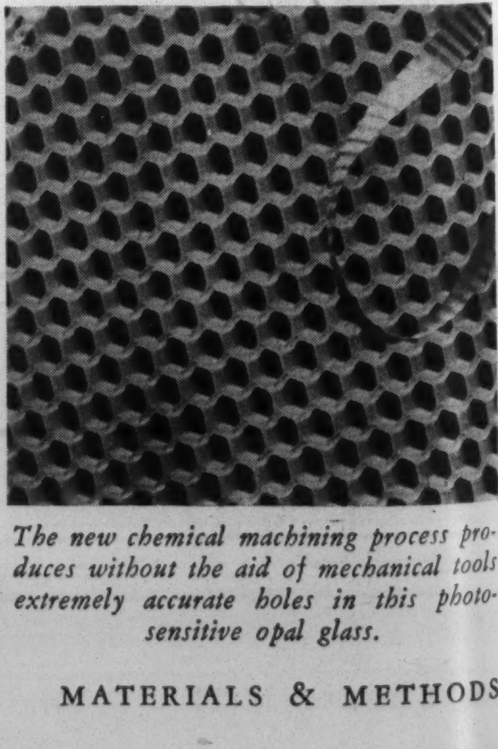
New Glass Can Be Machined with Chemicals

A new kind of glass which can be precision-machined through the use of ultraviolet light, heat and hydrofluoric acid to form intricately cut patterns of any desired shape and depth has been announced by *Corning Glass Works*, Corning, N. Y.

To this new glass, the latest in a series of photosensitive compositions first announced by the company in 1947 to produce permanent three-dimensional photographs in glass in a variety of colors, Corning has adapted an equally new process of chemical machining, which produces without the aid of mechanical tools, lace-like patterns.

In operation, the first step in the process is the printing of a design in the glass, using an ordinary photographic negative and ultra-violet light. Development is then accomplished by heating the glass to 1200 F for the required length of time, about 2 hr.

Next, the glass is immersed in a solution of hydrofluoric acid until the white areas are eaten through and removed, leaving



The new chemical machining process produces without the aid of mechanical tools extremely accurate holes in this photosensitive opal glass.

An Arwood casting saves time! money!

Arwood's engineering skill and production efficiency make it possible to produce the cam illustrated by the precision investment casting method.

This is a stainless steel release cam for food machinery. Originally it was to have been machined from a 2″ solid cube of steel. But made as an investment casting, all machining has been eliminated except the drilling of one small blind hole and the turning of the shank to a tolerance of ± .0005. Notice the details of the slot and cam groove which are held to tolerances of .004.

While the saving of valuable machining time is important, it is interesting, too, that an actual saving of 58% was made over the cost of making the cam by other methods.

Perhaps you have a production problem that Arwood can help you solve. Our engineers, with years of experience in many industries, often are able to make valuable suggestions that result in important savings in manufacturing.

For more complete information about the accuracy, the lower costs and the versatility of precision casting, write for our booklet, "A Critical Survey of Investment Castings."

ARWOOD

PRECISION CASTING CORP.

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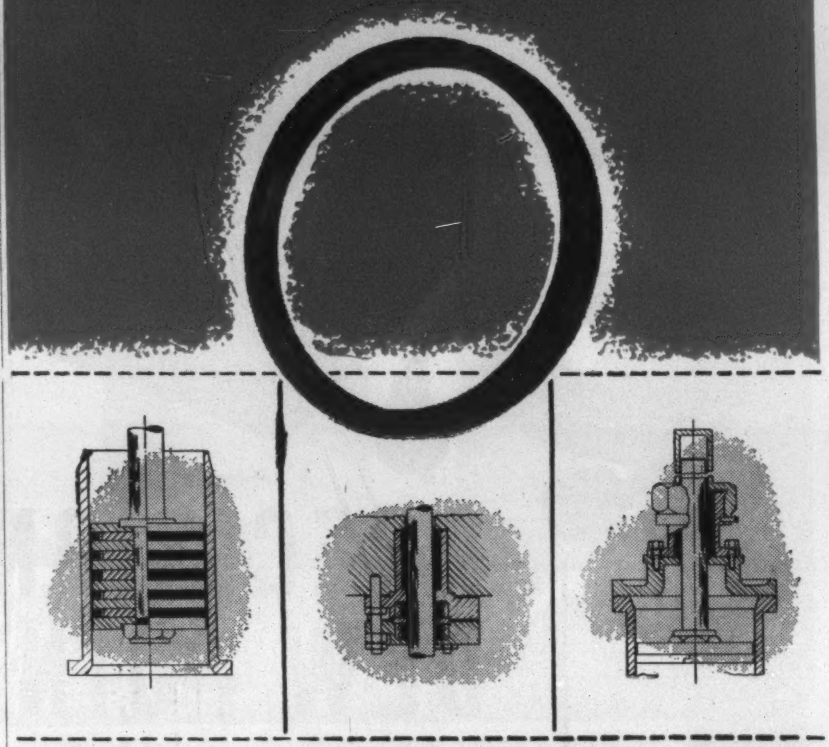
Plants: Brooklyn, N. Y., Groton, Conn., Tilton, N. H.

RETAIN PURITY by installing

MORGANITE

SELF-LUBRICATING • NON-CONTAMINATING

PISTON RINGS



IN COMPRESSORS, handling foods, chemicals, plastics, beverages and oxygen.

Completely efficient lubrication is inherent in the rings themselves — no oil or other lubrication is required during the life of the ring. Morganite Piston Rings are non-contaminating and impart no taste or odor. Ideal for compressors in oxygen service. Self-lubricating Morganite is also available in rotary seals, washers, valves, bearings, vanes, and other parts.

CONSULT OUR CATALOG in Sweet's File for Product Designers. Call or write for complete engineering data and recommendations on specific problems. Please supply drawings and specifications when requesting estimates.

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★ **The Alnor is the only dew point indicator that is a complete unit in itself . . . it is readily portable and does not require external coolants or auxiliary apparatus.**

★ **Controlled testing conditions are assured. Indications take place in an enclosed chamber . . . dew or fog is observed suspended in air — not on a polished surface. This means greater accuracy, faster reading — *every time.***

★ **Simple, direct operation of the Alnor Dewpointer assures laboratory accuracy by non-technical personnel. Substantial carrying case protects it against the usual hazards of portable use.**

★ **Available in three ranges — for dew points between minus 20 deg. F. and room temperatures from minus 80 deg. F. to 0 deg. F., and from minus 80 deg. F. to room temperature.**

Alnor

Write for Descriptive Bulletins. Illinois Testing Laboratories, Room 522, 420 N. LaSalle St., Chicago 10, Ill.

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

New Materials and Equipment

the remaining unexposed glass in the exact form of the original pattern.

By varying the length and intensity of light exposure through the photographic negative, the depth of acid penetration in the glass is said to be accurately controlled from shallow etching to complete erosion. In this way, sculptured figures or contoured shapes can be made by using a continuous tone negative with proper degrees of shading.

The new process is claimed to be especially suited to perforating holes of any shape having diameters of only a few thousandths of an inch and numbering up to several thousands per sq in. Designs as irregular as lace work can be photo-etched as readily as simple straight line patterns. The versatility of the process has already been demonstrated in the manufacture of printed electrical circuits for electronic instruments, and the company believes the new product will hasten further important advances in the electronics field.

Plastics-Aluminum Blend Is Substitute for Tin Foil

Reynolds Metals Co., Richmond, Va., has developed a substitute for tin, which is a blend of plastics with aluminum foil, made by coating aluminum sheets with plastic and bonding them under heat and pressure. Production of the new material is starting immediately, but all the present output will go to fill the requirements of the armed forces.

The two chief benefits claimed for the new product are a reduction in price and assurance of an adequate supply in an emergency.

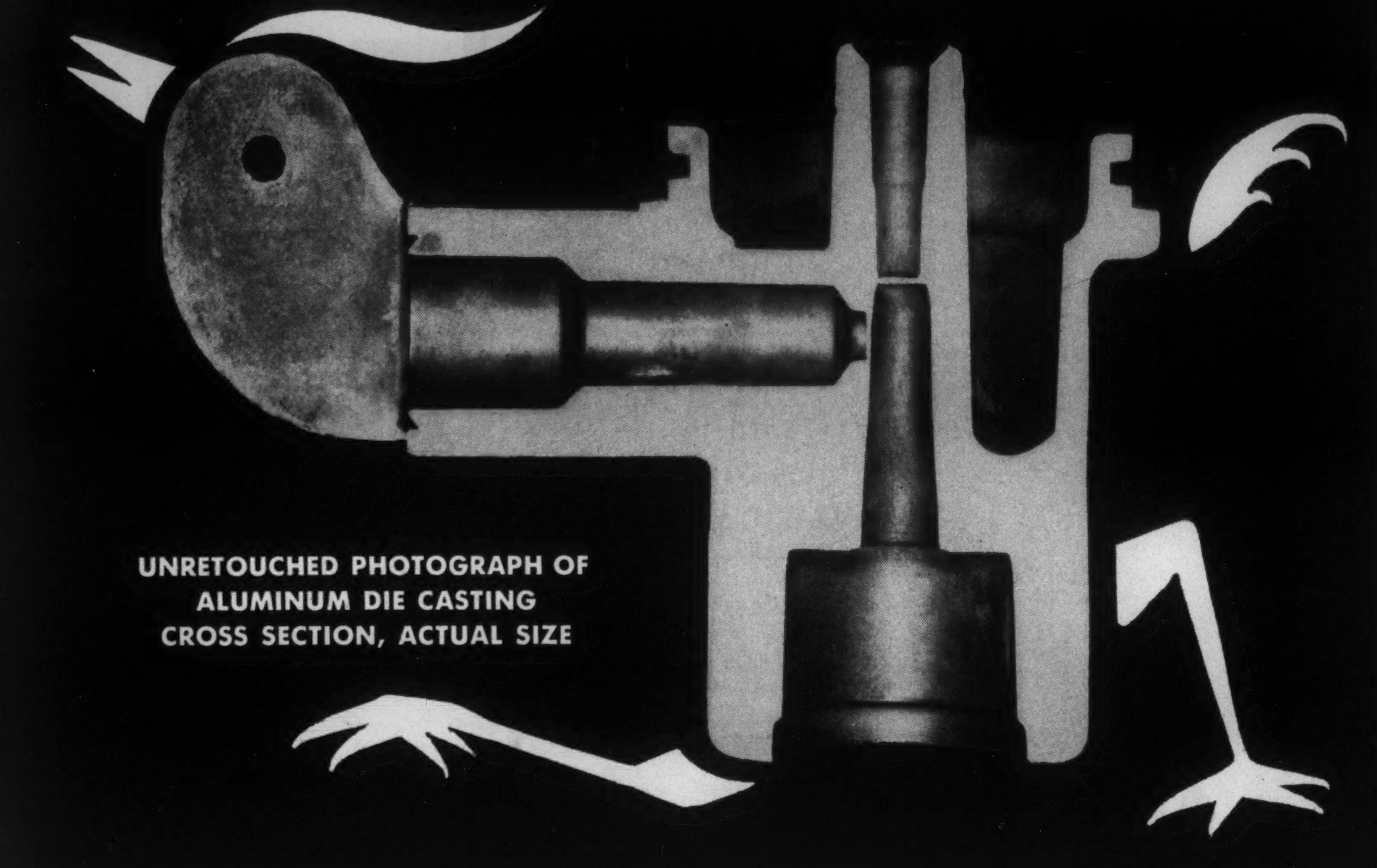
Six New Stabilizers for Latex Paints

The Chemical Div., *Borden Co.,* 350 Madison Ave., New York 17, has announced the development of six new stabilizers for latex paints. These are solutions which stabilize the paint's emulsion and account for 10 to 25% of the paint's total weight.

Quick drying and virtually odorless, latex paints can be applied easily with either brush or roller. They are said to leave no brush or lap marks, even if work is resumed on a partly painted surface several hours later. The tough latex paint film permits removal of grease or other stains without a smudge.

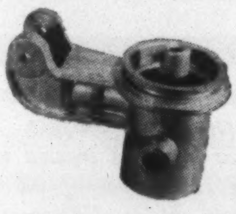
According to the Company, the new type of paint will cover practically any

Super Density is a Rare Bird



UNRETOUCHED PHOTOGRAPH OF
ALUMINUM DIE CASTING
CROSS SECTION, ACTUAL SIZE

. . . common to a LESTER

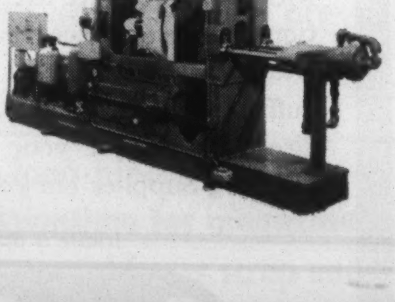


Here again is an example of how expert die casting technique, intelligent die design and a Lester machine make super-dense aluminum die casting possible. The part is an element of a hydraulic bumper jack, cast by Morton Manufacturing Company, in Omaha, Nebraska, on an early model HP-1-C.

As you can see, the wall thickness ranges from about 3/32" to over 3/8". Besides, the part was required to withstand 4000 pounds of test pressure—*and there have been less than 2% rejects!* Skillful die design and gating, and proper cooling of die and core allow the job to be run at the rate of 120 shots per hour.

Interested in what a Lester-Phoenix Die Casting Machine can do for you? Write Lester-Phoenix or the representative in your area listed below.

Write for your free copy of the Lester Press.



LESTER-PHOENIX DIE CASTING MACHINES

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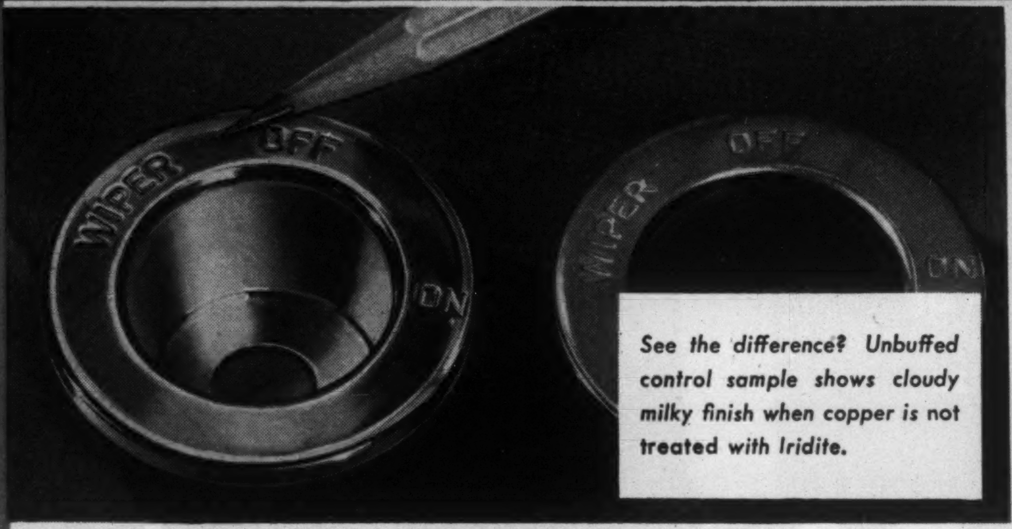
LOOK — what you get WITHOUT BUFFING



See the difference? Unbuffed control sample shows cloudy milky finish when copper is not treated with Iridite.

with IRIDITE® Metcote in COPPER-CHROME FINISHING

This sparkling bright finish is the result of just a simple dip in Iridite Metcote between the copper and chrome plating cycles! You actually get the clear, bright appearance of copper-nickel-chrome because the Iridite treatment gives maximum brilliance and clarity to the copper undercoating.

FORGET BUFFING COSTS, PR PLATING! Once you've properly prepared the base metal . . . steel sheet or zinc casting . . . you can completely forget buffing costs because no further buffing is required! And, there is no need to resort to PR plating or extra brightener in the copper plating solution because of the chemical polishing action of Iridite Metcote. The result? A pleasing clear, sparkling bright finish that is ideal for decorative products.

PROVE IT YOURSELF! Send us samples of your product for test-processing with copper, Iridite Metcote and chrome. Then make your own inspection and tests. Once you've seen your own product treated with this Iridite finishing system you'll never go back to slower, more costly buffing for your bright finishing. Start saving money *now*—write us direct or call in your nearest Iridite representative. Look under "Plating Supplies" in your classified telephone directory.

Iridite is approved under government specifications.

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Manufacturers of Iridite Finishes
for Corrosion Resistance and Paint Systems for Non-Ferrous Metals; ARP Plating Chemicals.

New Materials and Equipment

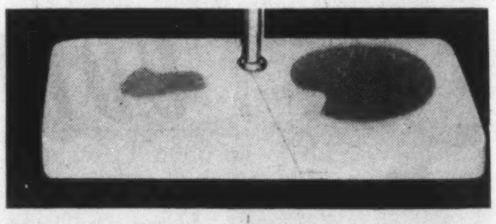
type of surface—wood, plaster or wallpaper—without an undercoat. In addition, the paints are easy to make, requiring only simple, cold mixing and blending.

The latex paint family derives its name from the fact that the principal binder is a latex-like emulsion, similar to that used in making synthetic rubber. Marketed under the trade names Cascola, Cascolac and Protovac, the stabilizers offer the following advantages: Elimination of heating and mixing preparations and storage problems, high water resistance, improved resistance to freezing, more brilliant color, and easier brushing.

Chemical Treatment Produces Oil-Retaining Rustproof Surface

Moving parts made of iron and steel can now get two-fold protection with a chemical treatment announced by *Octagon Process, Inc.*, 15 Bank St., Staten Island 1, N. Y.

Known as Rustshield 2, the new product is a phosphatizing compound which is said to change steel and iron surfaces to rustproof, highly absorbent nonmetallic areas. A surface so treated is an ideal base for the retention of lubricating oils. Because the surface is a coating produced from chemical interaction of the phosphate solution and the metal surface, it has greater adherence than any physically bonded coating, and metal parts so treated are claimed to remain properly lubricated far longer than smooth steel surfaces.

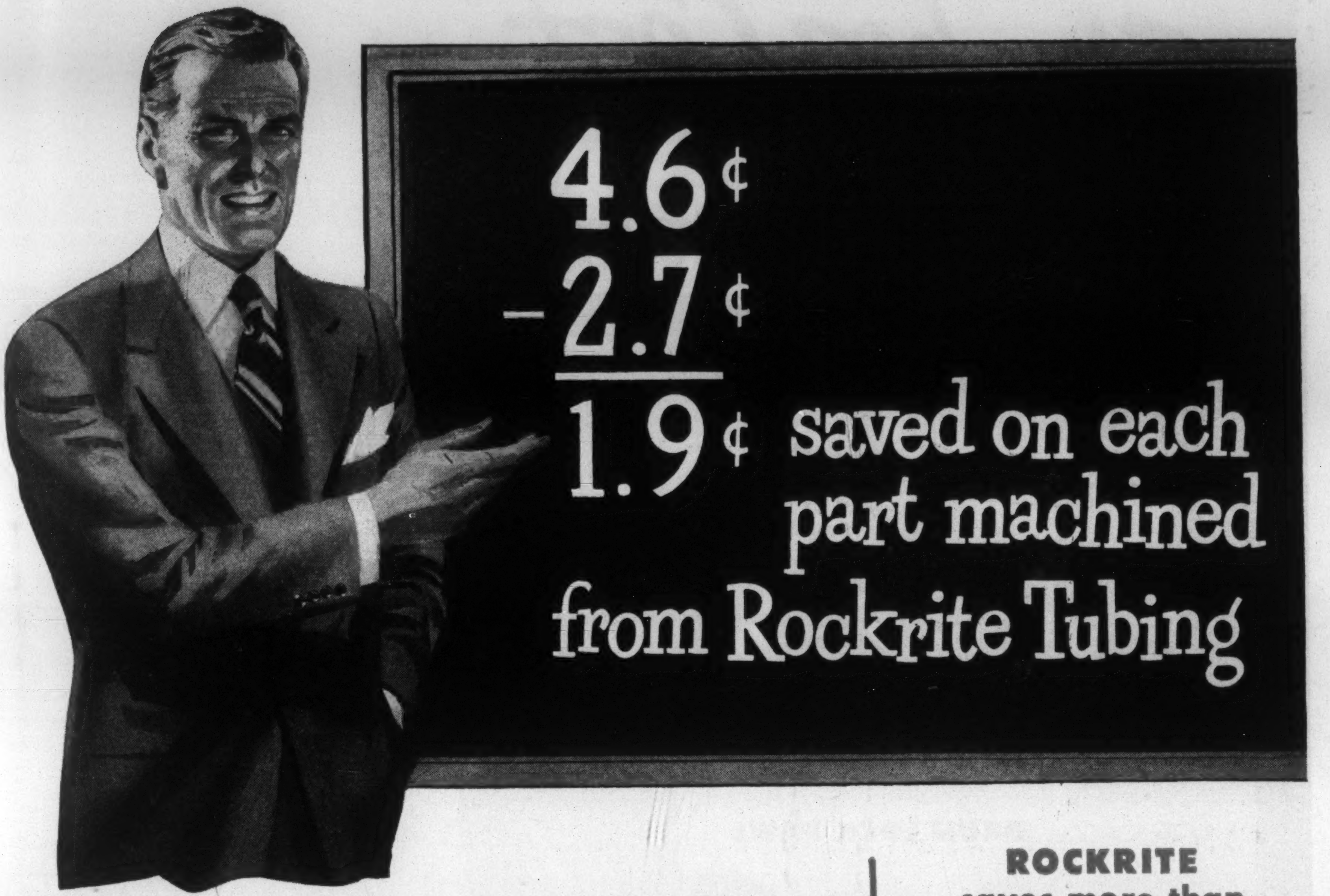


Demonstrated here are the oil retaining qualities of a Rustshielded surface. The piece of steel rod at left was treated with the compound and then 5 cc of oil was poured over the top. Note difference in size of oil spots.

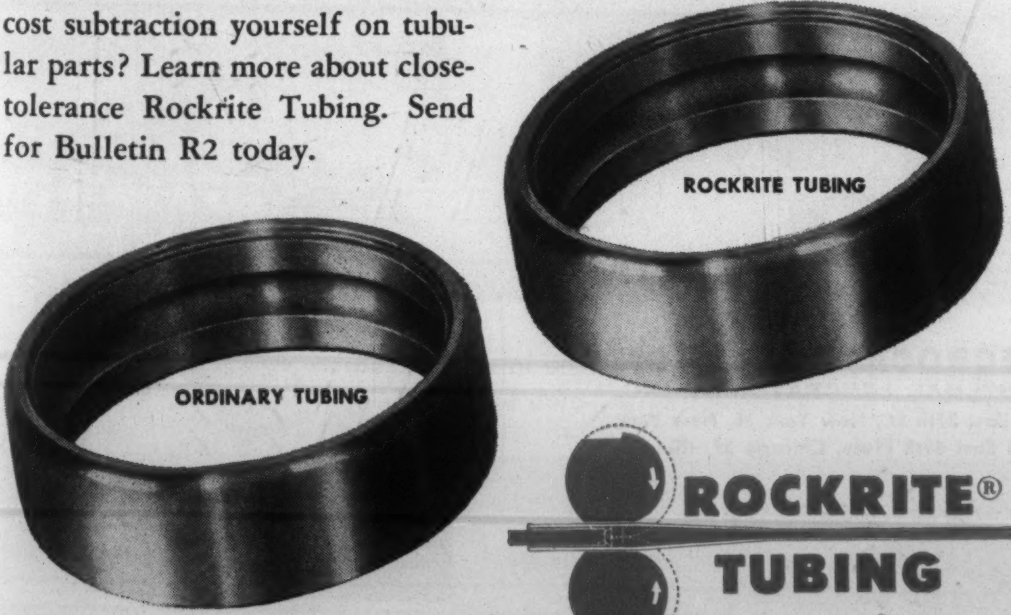
A simple, inexpensive immersion process which consists of precleaning with vapor degreaser, safety solvent, or an alkali cleaner and then rinsing, rustshielding, rinsing and treating with a passivating agent, the compound is used for the following parts: thrust washers, pump pistons, gears, valve roller pins, stems and guides, and bearing surfaces of every type.

The compound meets the requirements for phosphate coatings in the U. S. Army Ordnance Specification 57-0-2C, Type II,

HOW TO MAKE A PROFIT by simple subtraction


4.6¢
-2.7¢
1.9¢ saved on each part machined from Rockrite Tubing

This manufacturer knows his three R's—raceways, Rockrite and 'rithmetic. From actual records, he found ball bearing raceways machined from Rockrite Tubing instead of ordinary tube stock **cost 1.9¢ less per part.** • There are good reasons behind this profitable 'rithmetic. Sized by a distinctively different process, Rockrite Tubing has closer tolerances . . . needs less machining, permits higher cutting speeds and feeds. In this case, machine output is approximately 60% higher. Work surfaces are better, too. • Want to do some cost subtraction yourself on tubular parts? Learn more about close-tolerance Rockrite Tubing. Send for Bulletin R2 today.



ROCKRITE® TUBING

ROCKRITE saves more than any other tubing

- **Higher cutting speeds**
- **Tools last longer between grinds**
- **Work-surface finishes are better**
- **Machined parts have closer tolerances**
- **Stations on automatics are often released for additional operations**
- **Extra-long pieces available—less downtime for magazine stocking and fewer scrap ends**
- **Closer tolerances often eliminate necessity for machining on outside or inside**

TR-125A

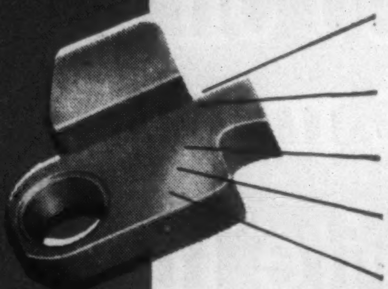
TUBE REDUCING CORPORATION • WALLINGTON, NEW JERSEY

Microcast®

Slashes Cost

Assembly of 6 Parts Cut to 2 Integral Parts

CLUTCH STOP PAWL



Microcast as 1 piece; formerly 4 piece assembly.

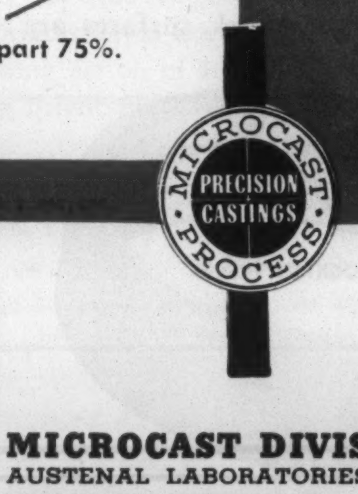
Used as cast, except for drilling and reaming one hole.

Sound structure — dimensionally uniform.

Milling operation and assembly eliminated.

Microcasting reduced cost on this part 20%.

DRUM LOCK PAWL



Microcast as 1 piece; formerly 2 piece assembly.

Used as cast, except for drilling and reaming one hole.

Special form cutters, gages, jigs, etc. eliminated.

Milling operation and assembly eliminated.

Microcasting reduced cost on this part 75%.

MICROCAST PRECISION CASTINGS PROCESS

MICROCAST offers design engineers many opportunities for product improvement of small components with substantial savings in cost. High melting point, non-machineable, non-forgeable alloys can be specified for economical quantity production, too. Write for complete information.

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MICROCAST

New Materials and Equipment

Class A. Rustshield finishes are said to be preferred to oxide coatings for ordnance components, such as gun barrels, as they are more resistant to abrasion, alkali, cleaning, corrosion and heat.

Paint Resin Provides Unusual Properties in Finishes

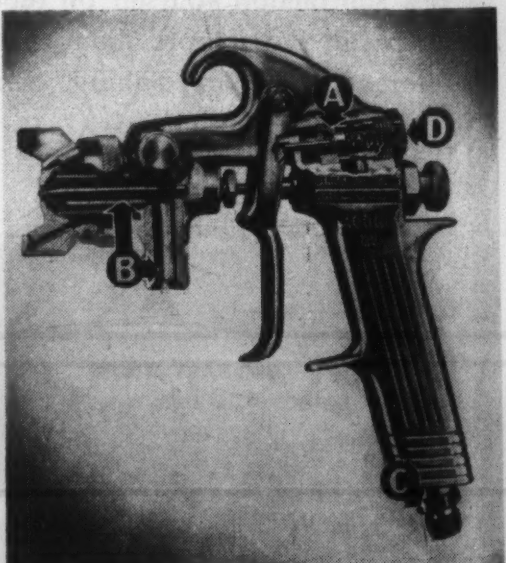
In an effort to ease a critical nation-wide shortage of castor oil, *American Cyanamid Co.,* 30 Rockefeller Plaza, New York 20, N. Y., has announced the development of a new resin paint ingredient, Cycopol S 203-5, which contains no castor oil.

Designed to meet military requirements for a fast-drying, durable finish for ammunition, the resin can be used in a variety of air drying and baking applications. Finishes produced with the new resin are said to combine rapid-drying characteristics, excellent color, gloss and valuable film properties.

Lightweight Spray Gun Produces Fine Finish

A new lightweight spray gun which reduces fatigue and has top quality features at a low price has been announced by *Binks Manufacturing Co.,* Chicago.

Known as Binks Model 29 Spray Gun, the unit's body is an aluminum casting which reduces the weight of the gun to



This new spray gun features (a) cartridge-type air valve; (b) brass and steel material passage; (c) air inlet in the handle's bottom; and (d) air inlet at back of gun.

"Putting Mettle into Metals Since 1896"
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METALS

Metals are our business—and yours too! Today our common problem is the shortage of all metals—the pressure of the civilian economy and defense demands is more than available supply can stand . . . up to the minute "know how" and time tested experience is more important than ever.

Better than half century of service and growth in all periods—War, Peace, "National Emergencies"—have "experienced" Belmont to cope with the current perplexities and problems. When that shortage strikes—or you wish to compare the merits of a substitute—contact Belmont . . . No effort will be spared to add Belmont experience and "know how" to yours—and that "probable" bottleneck can be smashed before it becomes serious.

"Belmont Metal of the Month" letters include market trends, statistics, and other helpful data—write to receive your copy—with our compliments.

Belmont SMELTING & REFINING WORKS, INC.
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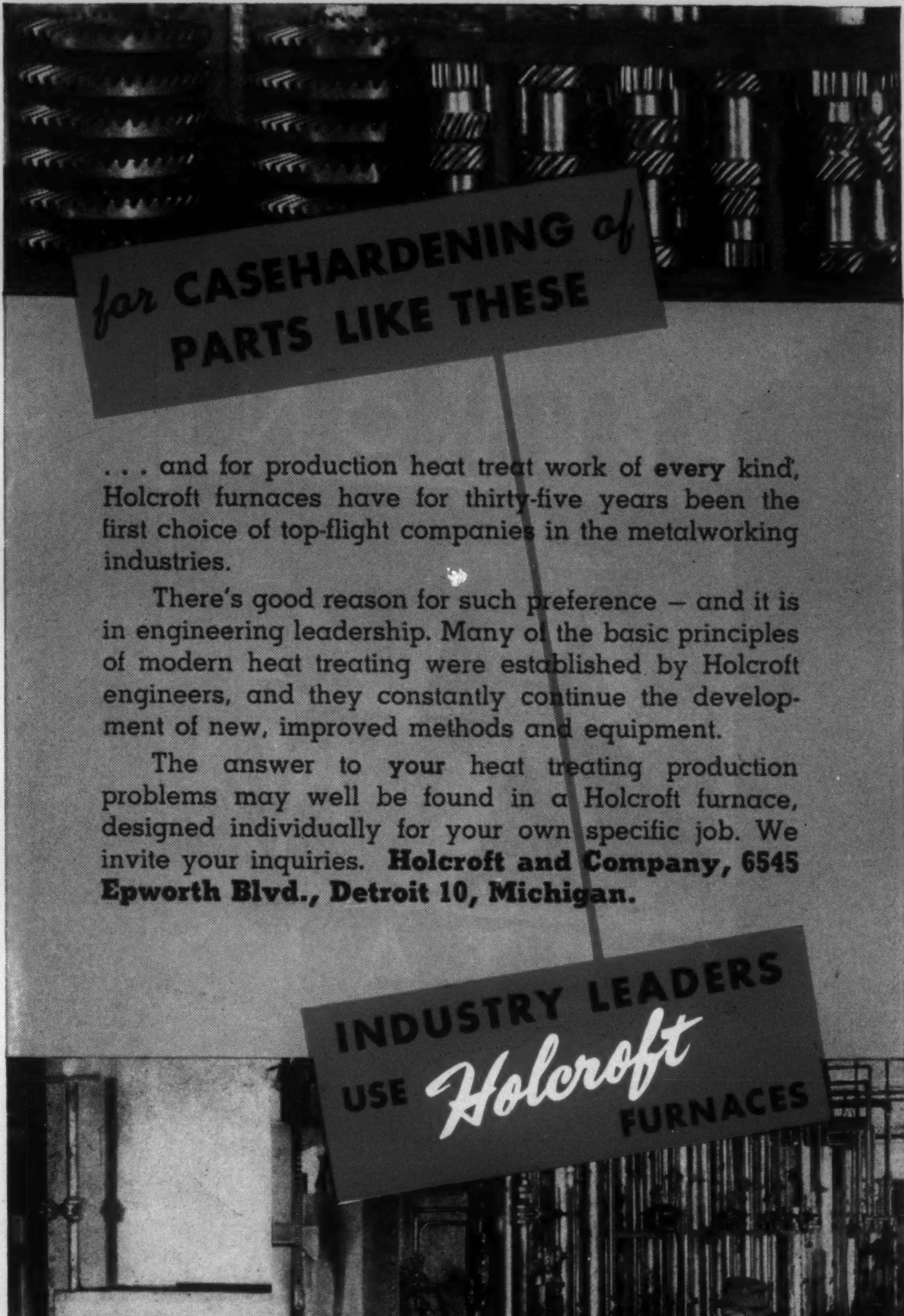

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There's good reason for such preference — and it is in engineering leadership. Many of the basic principles of modern heat treating were established by Holcroft engineers, and they constantly continue the development of new, improved methods and equipment.

The answer to your heat treating production problems may well be found in a Holcroft furnace, designed individually for your own specific job. We invite your inquiries. **Holcroft and Company, 6545 Epworth Blvd., Detroit 10, Michigan.**

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CANADA
Walker Metal Products, Ltd.
Windsor, Ontario

EUROPE
S. O. F. I. M.
Paris 8, France

just 20 oz. Because of this lighter weight, operator fatigue is cut down.

As proof of the gun's ability to perform, the manufacturer points out that this is the first gun in its price class to offer many of the quality features that are standard in high-price models. For example, this unit has a cartridge-type air valve for quicker replacement. Like higher priced guns, the Model 29 has a brass and steel material passage, which protects the aluminum casting from the corrosion and erosion caused by certain paints and other fluids. Air enters the gun through an inlet in the bottom of the handle. This arrangement distributes hose weight properly and makes it easier to manipulate the gun. Because the air passages in the new gun are large, internal air friction is low.

The new spray gun can be used to spray lacquers, synthetic enamels, paints and all other finishes and coatings of light or medium viscosity and is recommended for production-line, touch-up or maintenance painting.

Polyamide Resin Water Suspensions for Heat Adhesives and Coatings

General Mills, Inc., 2010 E. Hennepin Ave., Minneapolis 13, has announced expanded production of polyamide resin suspensoids. Opaque white water suspensions of the company's heat-sealing polyamide resins, the materials have found their largest volume use as heat-sealing adhesives and coatings. Individual formulations seal firmly to a wide variety of surfaces, including paper, cloth, cellophanes, metal foils, glass, leather, cork, wood and some plastics. Like the polyamide resins from which they are made, the suspensoids are resistant to greases, oils, water and water-vapor.

More recently, the materials have worked their way into the so-called wet stick adhesives, and they are said to show promise as soil resistant coatings for textiles, as protective and decorative coatings, as beater additives and tub sizes for paper, and as binders for sawdust, cork, leather, textile fibers, pigments and other materials.

The resins themselves, base products for the new suspensoids, are formed by the condensation of dimerized vegetable oil acids with ethylene diamine. In solution or as hot melts, they are widely used as heat-sealing adhesives and water-vapor resistant coatings. Although nonblocking, they heat seal at low temperature.

The company now makes polyamide

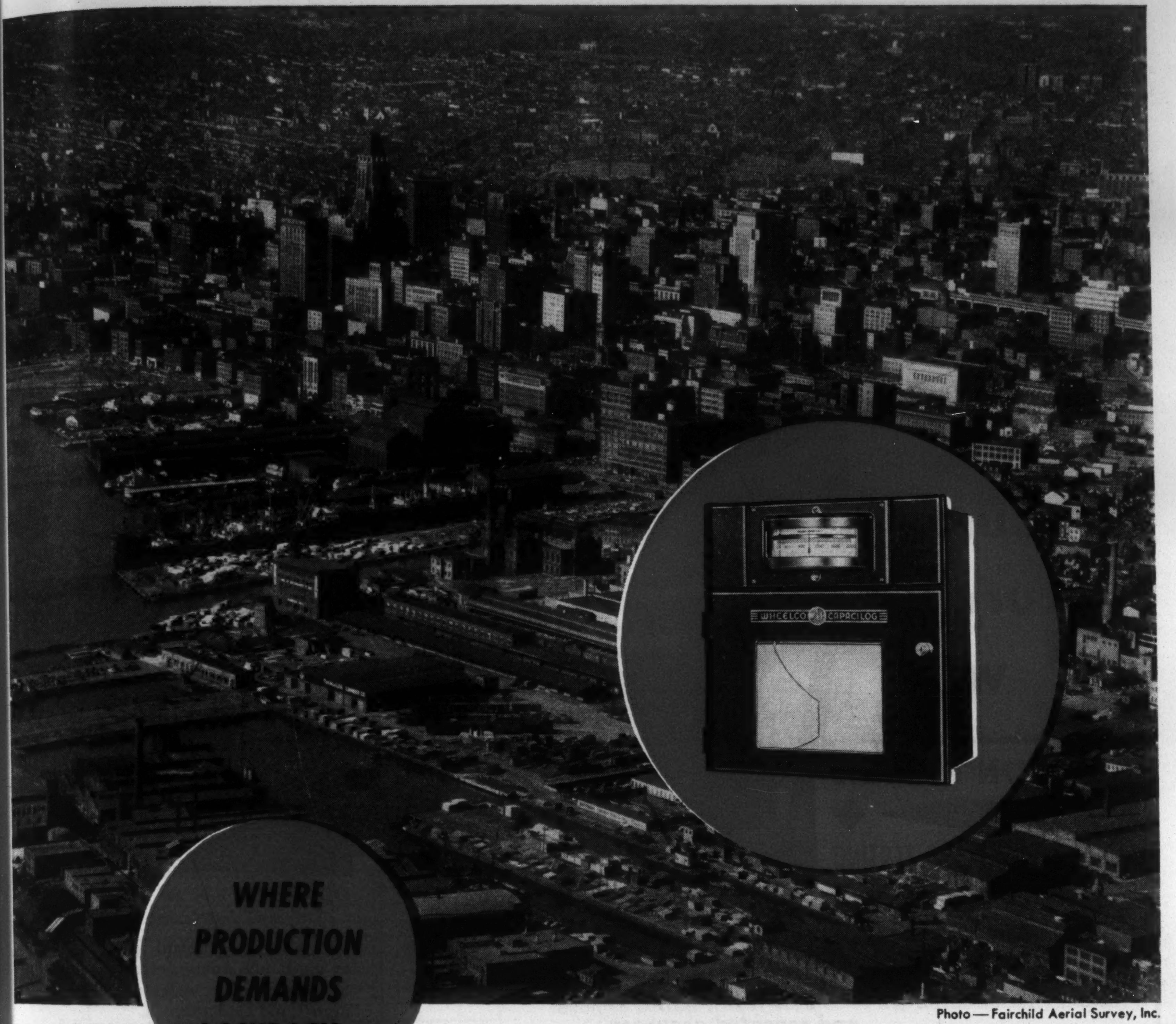


Photo — Fairchild Aerial Survey, Inc.

the wheelco capacilog recorder

Baltimore industry, like industry throughout the Eastern Seaboard, has need for a low cost, highly accurate instrument for the rapid measurement, indication, control and recording of electrically measurable variables in the production processes. That's why Baltimore production men, like progressive plant men throughout the nation, specify the Wheelco Capacilog, deflection type, strip chart recorder. They demand the most efficient, versatile and accurate recorder in the most reasonable price range.

Yes, for accuracy to ¼ of 1% of total scale, they specify the Wheelco Capacilog. Capacilogs are built for use with thermocouples and resistance thermometer measuring elements; as single or multipoint recorders; and with six different control combinations including pneumatic and proportioning types. Remember, in Baltimore and throughout the nation, wherever production demands accuracy, Wheelco Capacilog Recorders are specified.

Assembly line production and simplicity of construction make it possible to deliver most models within 20 days.

instrumentality When you specify Wheelco you specify Instrumentality — Wheelco's ability to design and build efficient and economical instruments to fulfill your needs for accurate and dependable control and recording.

Wheelco Instruments Company, 861 W. Harrison Street, Chicago 7, Illinois

wheelco *electronic controls*

Assured Accuracy with

TUKON TESTER
◆ *for* ◆
MICROHARDNESS TESTING

Researchers and scientists accept TUKON's precision and repeated accuracy

- Where minute indentations and extreme accuracy are necessary, the TUKON Microhardness Tester meets the most exacting requirements. A sensitive mechanically or electrically controlled system, with microscopic viewer, is employed.

On hardened steel, length of indentation with 100 gram load is .0016″, depth only .00005″; very small metallic crystal areas can be tested. TUKON models are available for testing delicate watch parts to properly prepared specimens of heavy machinery parts. TUKON is necessary in every metallurgical department.

Information on the correct TUKON Microhardness Tester for your work will be sent on request. Just give us details of the job.

ACCO WILSON
MECHANICAL INSTRUMENT DIVISION
AMERICAN CHAIN & CABLE
230-E Park Avenue, New York 17, N. Y.
TRADE MARK

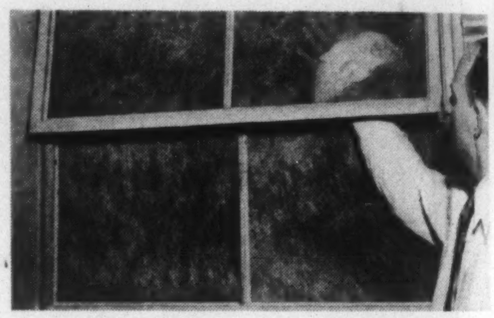
New Materials and Equipment

resin suspensoids of four types, each tailored for a series of applications. It expects to make still other types available as it continues its development program.

Translucent Plastic Sheeting Used in a Variety of Applications

A translucent plastic sheeting for use in a variety of structural and decorative applications is currently offered in flat panels by *Alsynite Co. of America,* 4670 DeSoto St., San Diego, Calif.

Advantages claimed for the flat plastic laminate are many. It is said to be shatterproof; eliminate glare by diffusing the light rays; fire resistant; permit only half as much heat transmission as glass; easy to install; light weight; and has high impact and load strength.



Demonstrated here are the plastic sheeting's translucent qualities.

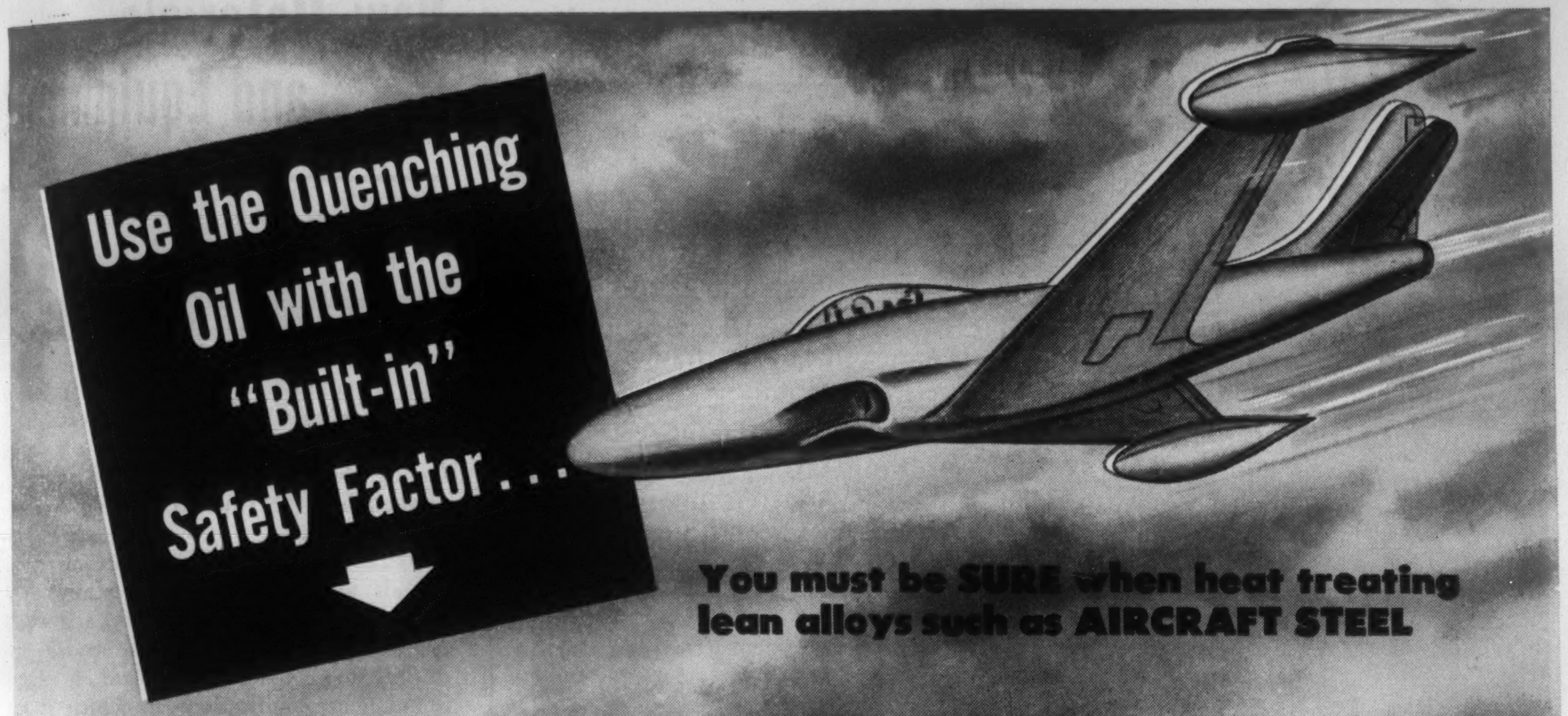
Alsynite's ease of use is an outstanding feature; it is said to be as easy to use as wood. It can be cut with a power or hand saw or shears, or drilled with ordinary tools. It can be fastened with nails, bolts, screws or mastic.

Available in six standard colors (opal, rose, green, leaf green, aqua and maize), the new laminate is made by combining resins and glass fibers under heat and pressure.

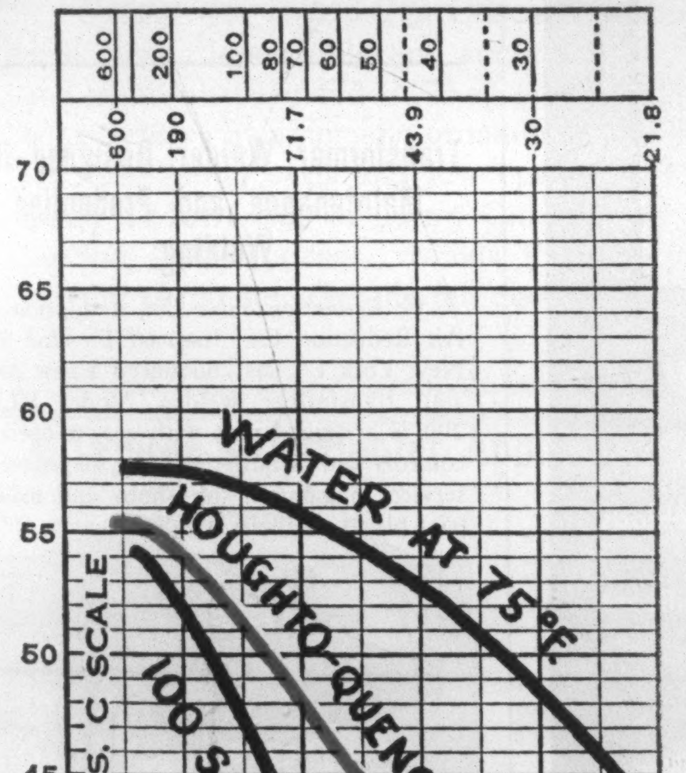
Plastic Piping Finding Increased Applications

Clopay Corp., Cincinnati, has announced the addition of Tuffstuff to its line of industrial plastics. The new material is a rigid, corrosion resistant plastic piping that is expected to find wide use in the chemical, petroleum, mining, food processing and plumbing fields.

Unplasticized polyvinyl chloride extrusions have been widely used in Europe since the early stages of World War II when metals were extremely critical. Chemical plants used this type of piping


Use the Quenching Oil with the "Built-in" Safety Factor . . .
You must be SURE when heat treating lean alloys such as AIRCRAFT STEEL

HOUGHTO-QUENCH "K"



A Jominy comparison of water at 75°F., 100-second mineral oil and Houghto-Quench "K" at 120°F., using AISI 8740 Steel.

Just as steel needs a high safety factor, so does your heat treating procedure. And you get it when you use Houghto-Quench "K", Houghton's brand new treated quenching oil developed specifically to provide speedier quenching of today's lean alloys.

You can be *sure* with Houghto-Quench "K". Its accelerated quenching properties are just what the heat treater must have for steels with hardenability characteristics in the *lower* ranges of the hardenability band.

It gives you that extra measure of safety which government specifications for aircraft steels (MIL-H-6875) demand. It eliminates experiments and costly rejects, because it quenches varying heats with equal dependability. The chart at the left proves the speed of Houghto-Quench "K" compared with water and straight mineral oil quenching.

With today's demands increasing daily for high speed quenching, we have stepped up production of Houghto-Quench "K" to make it more readily available. Write to E. F. Houghton & Co., Philadelphia 33, Pa., for prices and descriptive material.

HOUGHTO-QUENCH "K"
. . . a product of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

ROTO FINISH
Trademark Reg. U. S. Pat. Office

. . . gives you precision finishes in a *hurry* !

Still using hand methods for removing burrs and other surface imperfections on your precision parts? Then, investigate Roto-Finish, the fast, low-cost method of improving the surface of critical and diverse materials without disturbing precise dimensions. Send in your parts, please include a finished sample for a guide, to Roto-Finish's extensive laboratory for free analysis and recommendations. Let us prove how Roto-Finish lets you utilize your skilled labor more productively. There is no obligation.

before
after

get these benefits that only ROTO-FINISH can give you . . .

- Saves you manpower and time by eliminating costly hand methods of deburring, descaling and surface improvement.
- Maintains *exact* tolerances on precision parts with no significant dimensional changes.
- Prepares raw forgings and castings for precision machining.
- Produces accurate radii on exposed edges and corners.
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- Removes burrs after precision finishes.

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ORIGINATORS OF THE ROTO-FINISH PROCESSES

New Materials and Equipment

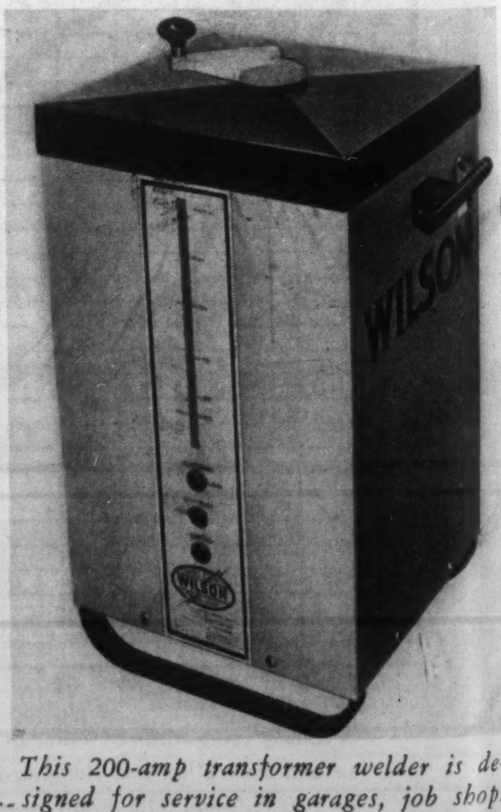
as a replacement for special alloys to carry both acids and alkalis. In one plant, where stainless steel had been holding up 6 to 9 months, plastic piping, it is said, has held up for more than 2½ years. The petroleum industry in Europe is also finding the plastic piping to be superior to metallic pipe since crude oils are extremely acidic.

Extruded rigid polyvinyl chloride compounds are also being successfully used as replacements for copper, steel and wood processing equipment. In the textile industry, too, Tuffstuff is said to have found many applications in which it far outperforms metallic material.

Extruded in U. S. standard pipe and tubing sizes, the new product, an unplasticized polyvinyl chloride compound, is said to be impervious to concentrated acids, alkalis and many solvents. It is rigid, but not brittle. Welding, cementing and bending can be easily accomplished by the usual techniques.

Transformer Welder Designed for Maintenance and Production Welding

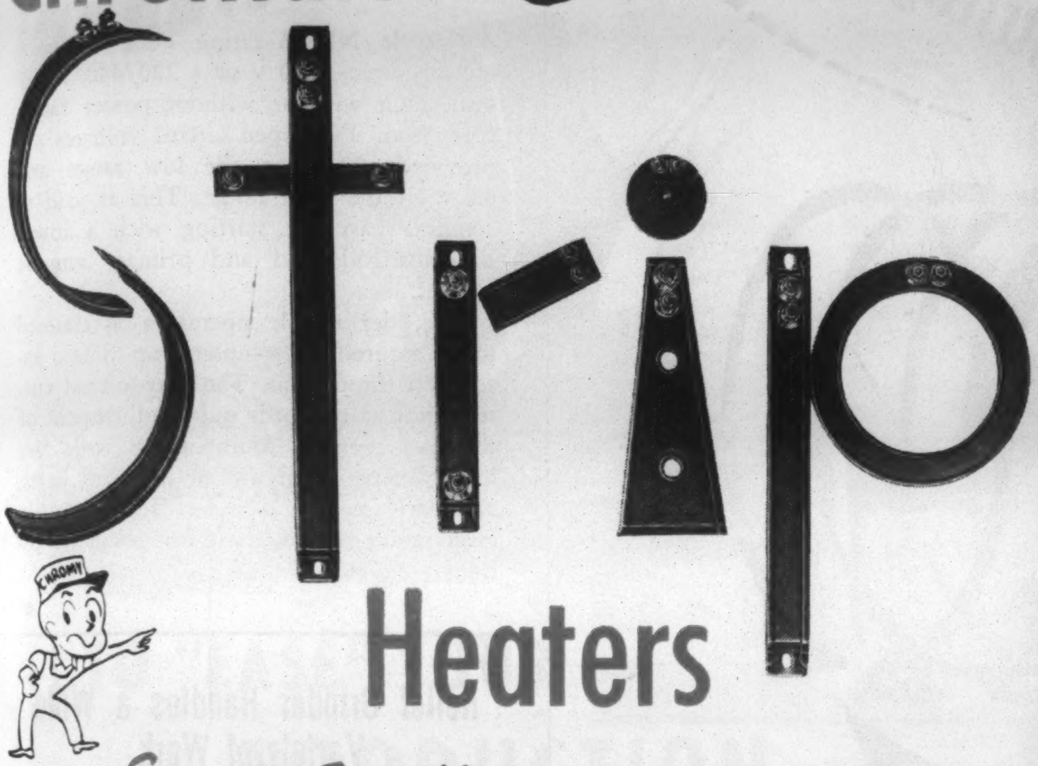
Air Reduction Sales Co., a division of Air Reduction Co., Inc., 60 E. 42nd St., New York 17, has announced a new 200-amp transformer welder. Model MCM 200 is a rugged unit with easy-to-operate controls and is built for long, dependable service in garages, job shops and industrial plants. It offers a full 200-amp, 50%



This 200-amp transformer welder is designed for service in garages, job shops and industrial plants.

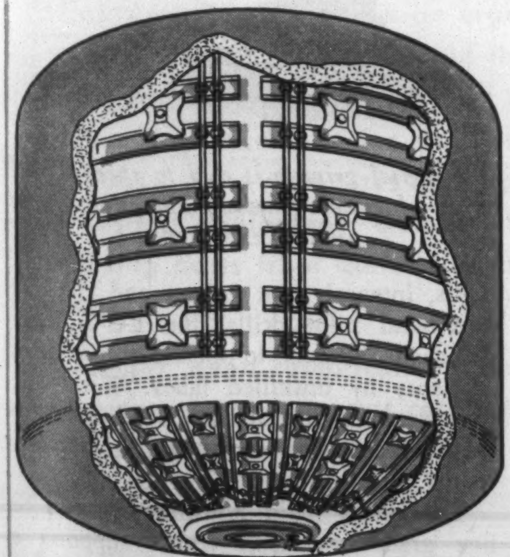
Industry's Most Versatile Heat Source

Chromalox *Electric* Strip Heaters

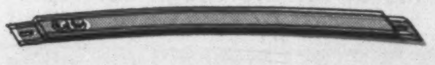


Easy to Install CHROMALOX Electric Strip Heaters give clean, dependable and accurately controlled heat where and when heat is needed. They produce uniform and accurate temperatures by automatic or manual controls. Low initial costs, low installation costs and low operating costs are among the many advantages of using CHROMALOX Strip Heaters for heating liquids, gases, viscous fluids, tanks, platens, molds, moving parts, etc. Get the full details now.

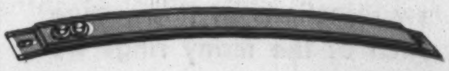
A Typical Strip Heater Application from Our Files



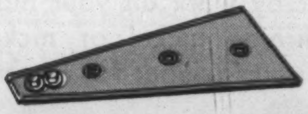
Rugged, easily installed Chromalox Strip Heaters assure accurate temperature, dependable around-the-clock service.



Strip Heaters curved lengthwise at the factory fit snugly to tank perimeter and . . .



Strip Heaters curved slightly as installed conform to shape of convex kettle bottom, while . . .

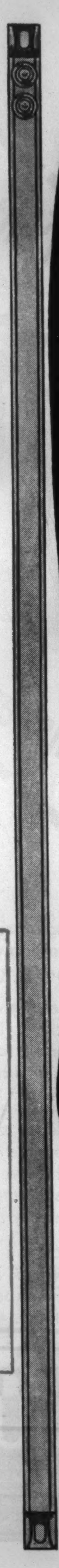


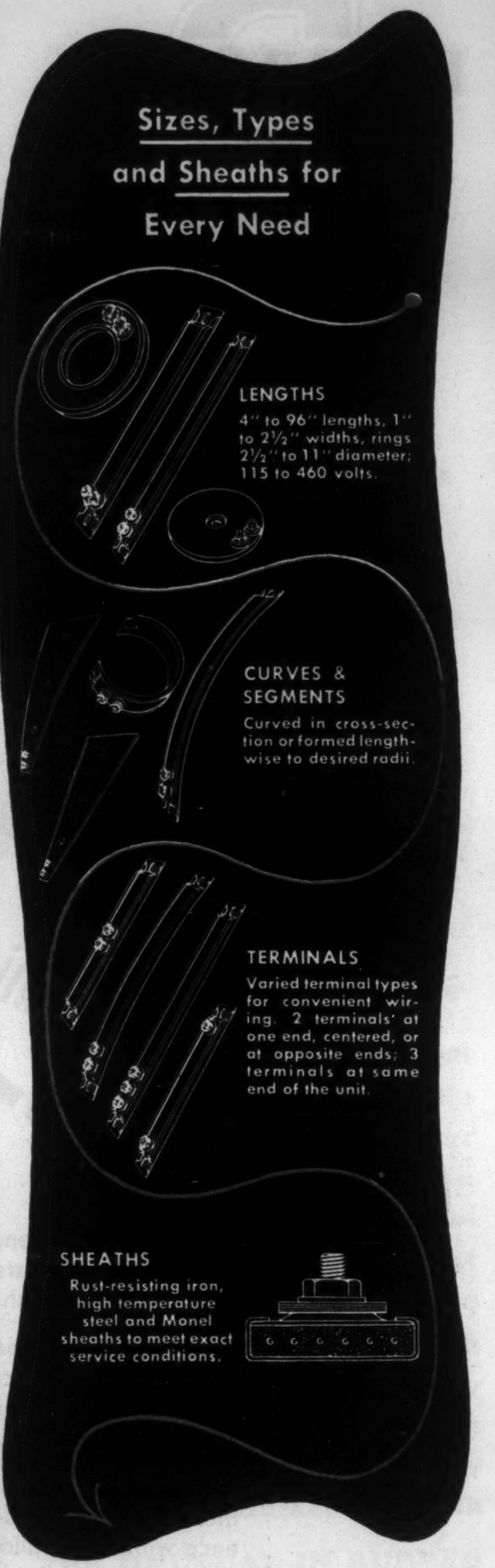
Segment Heaters fill the gaps.

IC-59

CHROMALOX

Electric Heat for Modern Industry





Sizes, Types and Sheaths for Every Need

LENGTHS
4" to 96" lengths, 1" to 2½" widths, rings 2½" to 11" diameter; 115 to 460 volts.

CURVES & SEGMENTS
Curved in cross-section or formed lengthwise to desired radii.

TERMINALS
Varied terminal types for convenient wiring. 2 terminals at one end, centered, or at opposite ends; 3 terminals at same end of the unit.

SHEATHS
Rust-resisting iron, high temperature steel and Monel sheaths to meet exact service conditions.

Want Ideas?

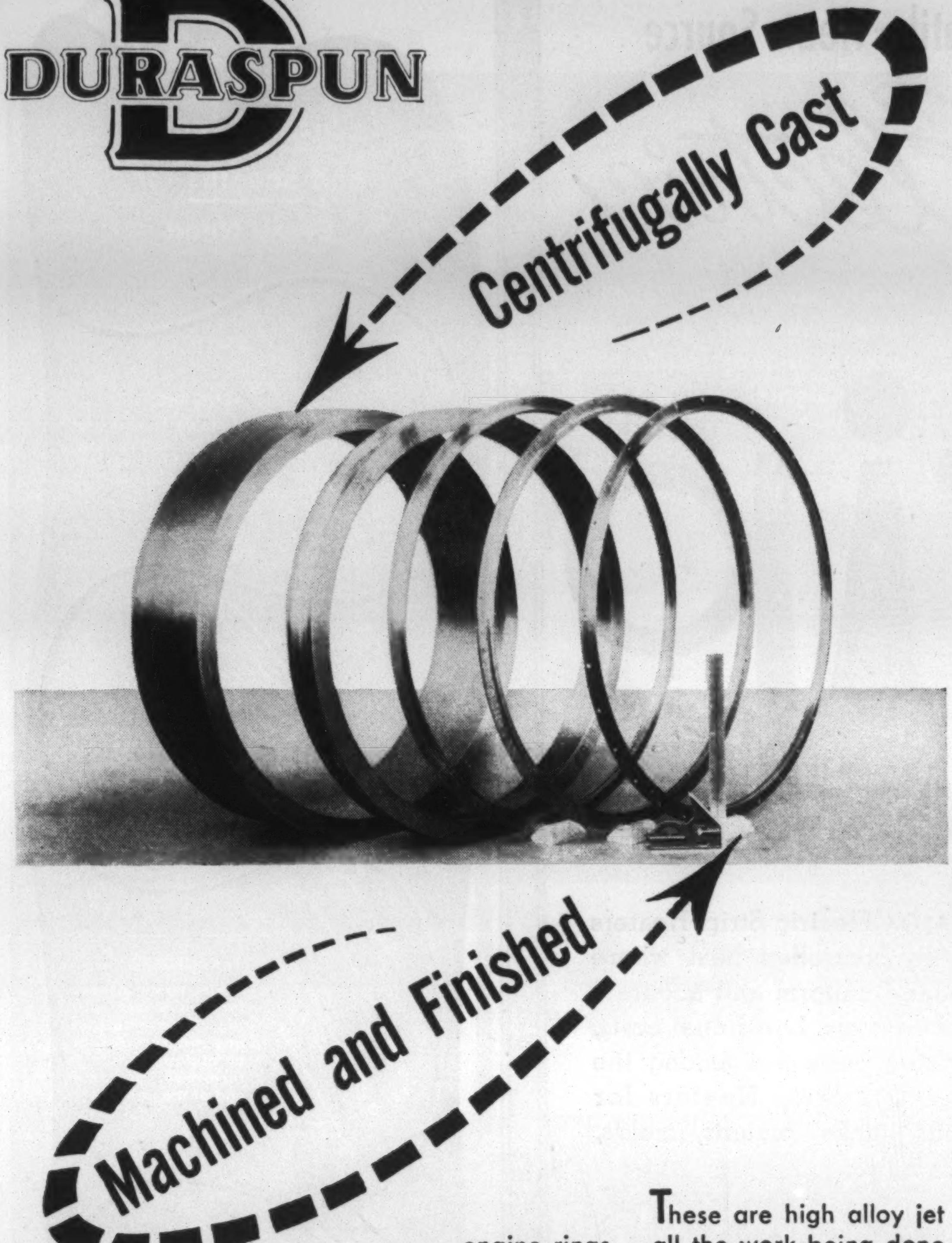
on how to use Chromalox Electric Heaters in your plant

CHROMALOX
Electric Heating Units

Write for the data-packed Catalog 50 which describes many types of Chromalox Electric Heaters and how to apply them. It's yours without obligation.

EDWIN L. WIEGAND COMPANY
7523 Thomas Blvd., Pittsburgh 8, Pa.

DURASPUN



These are high alloy jet engine rings . . . all the work being done in our shop, starting with the centrifugal casting right through to the finished ring.

Centrifugally cast metal gives an exceptionally fine, dense, uniform grain structure. The strength of the metal approaches that imparted to a bar or ingot when it is hot forged. It produces an ideal metal for the tough service required of jet engine parts.

Incidentally, as evidence of our knowledge of and experience with tough alloy castings — static as well as centrifugal — the records show very few rejections by this engine manufacturer who subjected each of the many rings we furnished to his own very rigid tests.

May we suggest that you let Duraloy work on your high alloy castings — chrome iron, chrome nickel or nickel chrome? We have the experience and facilities for turning out high quality castings.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. · *Eastern Office:* 12 East 41st Street, New York 17, N. Y.

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New Materials and Equipment

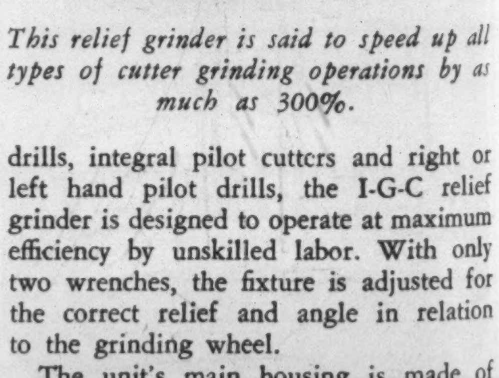
duty cycle, NEMA rating. Four variations are available—220 v or a 220/440/550 v unit, each with or without power factor correction. Two open circuit voltages are provided—80 v on the low range and 55 v on the high range. This is said to combine easy arc starting with a lower Kva demand load and primary ampere current.

Safe, dependable operation is claimed to be assured by complete, up-to-date insulation throughout. The easy-to-read current indicator affords quick adjustment of welding current. Maintenance costs are low because there are no moving parts, and each part is designed for long life even under the toughest operating conditions.

Relief Grinder Handles a Wide Variety of Work

A new relief grinder that is said to speed up all types of cutter grinding operations by as much as 300% has been announced by *Western Aero Industries,* 3305 Burton Ave., Burbank, Calif.

Developed to handle a wide variety of work-countersinks of all types, center drills, integral pilot cutters and right or left hand pilot drills, the I-G-C relief grinder is designed to operate at maximum efficiency by unskilled labor. With only two wrenches, the fixture is adjusted for the correct relief and angle in relation to the grinding wheel.



This relief grinder is said to speed up all types of cutter grinding operations by as much as 300%.

The unit's main housing is made of fine grade cast iron which supports a hardened and ground spindle on two large bearing surfaces that require only periodic oiling. The cam is hardened tool steel with steel adjustment pins; the fixture swings 90 deg to the right or left, and the base is calibrated in 5-deg increments.

Fixture loading can be done in three steps: (1) correct size collet is inserted; (2) work to be ground is placed in the

If you are "PINCHED"
We have the "SHOEHORN"

TO "EASE" YOUR
PRODUCTION
PROBLEMS

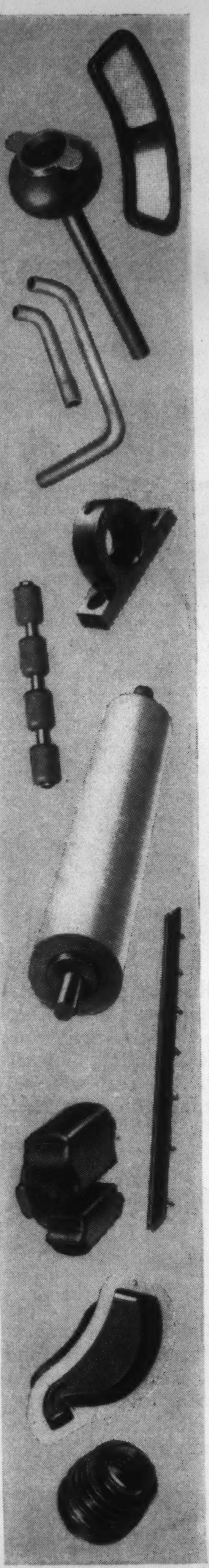
Yes, you'll discover that production costs can be lowered and production problems minimized through the use of die cast magnesium and aluminum alloys. These new lightweight, yet tough, metals also greatly decrease the weight of your products. Through die casting, greater scope is offered for carrying out the designers' ideas—more freedom of design is allowed.

LITEMETAL DIECAST, INC. is an organization of specialists—men thoroughly experienced in the casting and machining of magnesium and aluminum alloys. Our equipment includes big machines for big jobs—little machines for little jobs . the right sizes and types of the most modern die casting equipment. Our facilities are complete for producing parts from the size of a button to large cable spools.

Remember, even comparatively simple dies can be used to die cast parts at lowest cost conditions and great savings can also be made in labor formerly required for machining and finishing.

Write today for literature and
design information.
Quick action on inquiries.

LITEMETAL DICAST, Inc.
A DIVISION OF HAYES INDUSTRIES
1933 WILDWOOD AVE. · JACKSON, MICHIGAN
PLANT AND EXECUTIVE OFFICES



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YOUR INDUSTRY
is on this list—

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LEATHER

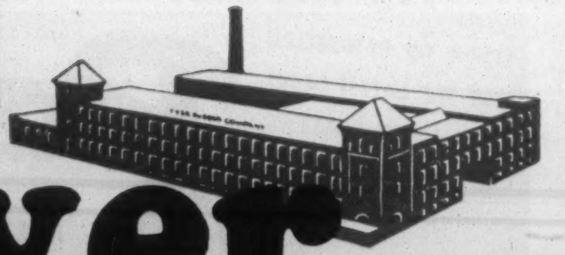
you can benefit from

Tyer

Skill, Imagination & Service

Tyer technical knowledge and original thinking are available to you to make Rubber, our product, more useful to you in *your* product. The same know-how and resourcefulness that led Tyer to originate White Rubber and Elastic Webbing in the early days of the industry, have enabled Tyer, through war and peace, to supply American manufacturers with

THE UNUSUAL IN RUBBER
SINCE 1856



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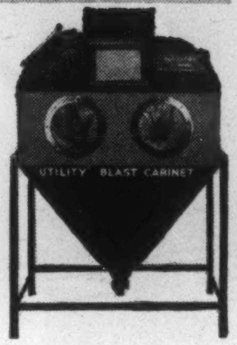
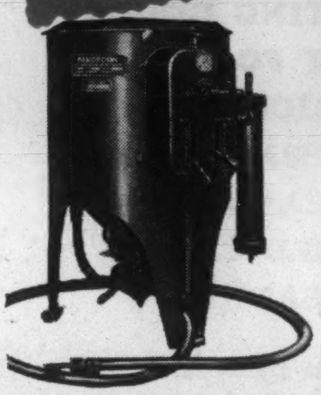
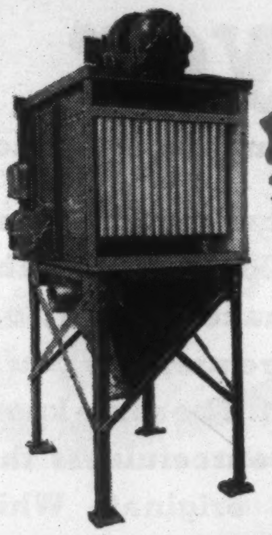
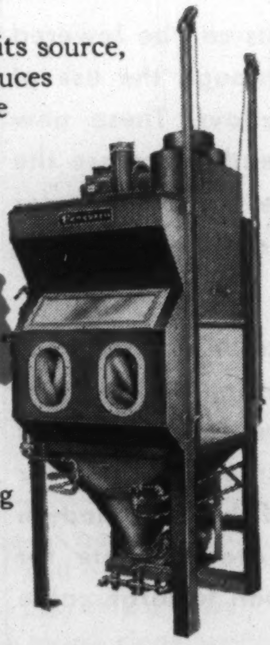








Here's how Pangborn
Solves these Problems
with this modern equipment

BLAST CLEANING!

Blast Cleaning Cabinet quickly and easily cleans rust, grime, dirt, paint, etc., from metal parts. Produces a clean, smooth surface on pieces up to 60″ x 36″. Models available from $315.00 and up.

Blast Cleaning Machine not only removes rust, dirt, scale, etc., but is ideal for maintenance and many other uses. Cleans large objects such as bridges, structural work, tanks before painting. Six sizes, portable or stationary, from $170.00 and up.

DUST COLLECTING!

Unit Dust Collector stops dust at its source, minimizes machine wear and tear, reduces housekeeping and general maintenance costs. Solves many grinding and polishing nuisances. Reduces material losses. Models from $286.00 and up.

PRECISION FINISHING!

Hydro-Finish Cabinet uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001″. Models from $1295.00 and up.

LOOK TO PANGBORN FOR THE LATEST DEVELOPMENTS IN BLAST CLEANING AND DUST CONTROL EQUIPMENT

Pangborn

MAIL COUPON for full details

(Check for more information)
☐ Blast Cleaning Cabinets
☐ Blast Cleaning Machines
☐ Unit Dust Collectors
☐ Hydro-Finish Cabinets

PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.

Gentlemen: Please send me more information on the equipment I've checked at the left.

Name..
Company..
Address..
City..............................Zone........State........

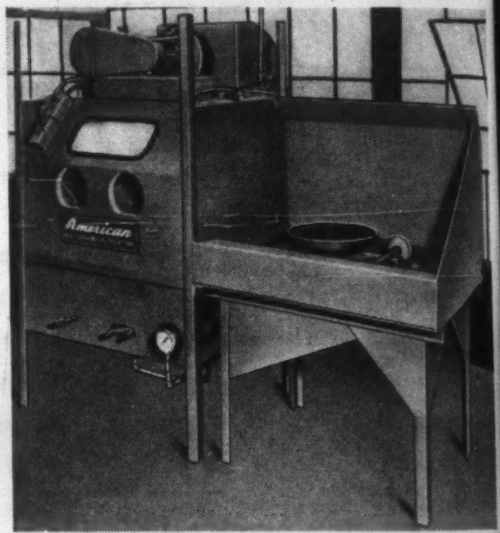
New Materials and Equipment

collet and locked in position with the hand wheel; (3) hand wheel is turned to rotate work against the grinding wheel. A locking pin holds the spindle rigid while the collet and work are being tightened.

Wet Blast Machine Offers Many Special Features

A new wet blast machine with many special features for improved operation and reduced maintenance is currently being offered by *American Wheelabrator & Equipment Corp.*, Mishawaka, Ind.

Among the many special features incorporated in the new unit is a vertical pump for slurry recirculation. It is adaptable to rugged service, and because of its position, it eliminates all suction piping, valves, fittings and labor for removing them for inspection of the pump. It is always primed by flooded-type suction, and the operation of valves for starting or stopping is said to be unnecessary. Loss of slurry through leakage is eliminated as there are no packing glands.



This wet blast machine is designed to answer wet blasting problems facing production men.

A reset timer is available on the Liquamatte, which tells at a glance the number of blasting hours that the abrasive has been in the machine. It also lets the operator know when it is time to change the abrasive and makes it easier for him to avoid wasting it. When the abrasive does need changing, an air ejector is available for blowing the slurry through a length of hose, either to a sump pit or to barrels.

As a safety feature, the unit's height is such that the average worker will be able to stand on the floor with no platform needed. A clear view of the work is easily available through the large vision

PANGBORN ROTOBLAST* CABINET CLEANS UP TO 200 ENGINE BLOCKS AN HOUR

at world's largest independent jobbing foundry

ABOVE: This rear view of Campbell, Wyant, Cannon's Pangborn "ES" ROTOBLAST Cabinet shows the conveyor system and four ROTOBLAST Machines. Inside the cabinet, the conveyor stops in front of each ROTOBLAST unit and slowly revolves the casting in the blast stream to assure complete cleaning.

Loading the heavy cylinder blocks on the conveyor is easily handled by two men.

ROTOBLAST . . .

- **AVES LABOR** with push-button peration
- **AVES SPACE** because machines re compact
- **AVES TIME** by cleaning more ads per day
- **AVES POWER** since no compressor is needed
- **AVES TOOLS** because all scale removed

BLAST CLEANING at Campbell, Wyant, Cannon Foundry Co., of Muskegon, Mich., is fast, efficient and *mechanized!* And the secret of this performance is two Pangborn "ES" ROTOBLAST Cabinets like that shown above. Heavy engine blocks can be cleaned at a rate of *200 an hour* . . . and cleaning is automatic! The result is faster, better, cheaper blast cleaning than ever experienced with other equipment.

Campbell, Wyant, Cannon started to mechanize their cleaning operation in 1937 . . . when they installed one of the first Pangborn monorail ROTOBLAST Cabinets. Later they installed a second Cabinet to meet production demands. As a result cleaning costs have been even further reduced, and there's no cleaning room bottleneck. Cleaning is a simple, automatic operation with high-quality work assured.

GET THE COMPLETE ROTOBLAST STORY: Bulletin 214 is informative and covers many applications. Write for your free copy to: Pangborn Corporation, 1700 Pangborn Blvd., Hagerstown, Md.

FOUNDRY EQUIPMENT MEMBER FEMA MANUFACTURERS ASSOCIATION INC.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment.

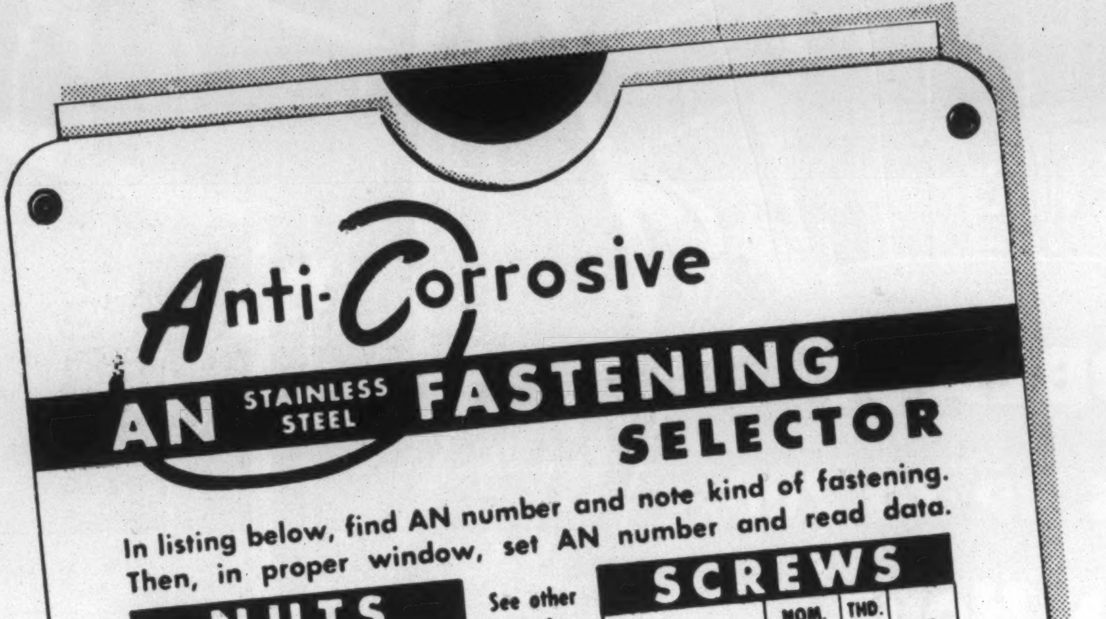
Pangborn

BLAST CLEANS CHEAPER

with the right equipment for every job

Up a Tree?

Not enough hours in your day? Here's a handy slide-chart to make your job simpler and save valuable time! This FREE chart instantly identifies A-N Nos. pertaining to stainless steel nuts, screws, bolts, rivets, cotter pins, washers; gives sizes, other data. Write for your FREE copy of Chart 51L TODAY!



Anti-Corrosive
AN STAINLESS STEEL FASTENING SELECTOR

In listing below, find AN number and note kind of fastening. Then, in proper window, set AN number and read data.

NUTS

NUMBER	NOM. SCREW SIZE	THD. PER IN.	CAT. PAGE
AN 310-C18	1-1/8*	12	22

*Prices and deliveries on request

See other side for RIVETS COTTER PINS WASHERS

SCREWS

NUMBER	NOM. SCREW SIZE	THD. PER IN.	CAT. PAGE
AN 501-C1	#1	72	11

Last DASH NO indicates length in sixteenths inch

AN3 to AN20 Hexagon Head, Fine Thread, Class 3 Fit Aircraft Bolts with hole drilled in shank
C—Corrosion Resisting Steel (Stainless Steel) to Spec. AN-QQ-S-770, Condition QT, Class II (Type 431).
H—Indicates drilled hole in head of Bolt
A—Indicates no drilled hole in shank of Bolt.
Last Dash No—Refer to drawing for length of Bolt

Number	Size	Thd./In.	Number	Size	Thd./In.	Number	Size	Thd./In.
AN3	10	32	AN7	7/16	20	AN14	7/8	14
AN4	1/4	28	AN8	1/2	20	AN16	1	14
AN5	5/16	24	AN9	9/16	18	AN18	1-1/8	12
AN6	3/8	24	AN10	5/8	18	AN20	1-1/4	12
			AN12	3/4	16			

AN310 Castellated Nuts, Fine Thread, Class 3 Fit.†
AN315 Hexagon Plain Nuts, Fine Thread, Class 3 Fit.†
AN316 Hexagon Double Chamfered, Double Countersunk Check Nuts, Fine Thread, Class 3 Fit.†
AN320 Hexagon Shear Nuts, Fine Thread, Class 3 Fit.†
AN340 Machine Screw Nuts, Coarse Thread, Class 2 Fit.‡
AN345 Machine Screw Nuts, Fine Thread, Class 2 Fit.‡
AN381 Corrosion Resisting Steel Cotter Pins to Spec. FF-P-386a, Amendment 2, Type C (Type 302)
AN427 100° Flat Countersunk Head Rivets } F—Corrosion Resisting (Stainless) Steel to Spec AN-W-24, Grade G, Condition A (Type 302 or Type 304 annealed).
Head Rivets Coarse Thread, Class 2 Fit.§

Anti-Corrosive
Metal Products Co., Inc.
Manufacturers of STAINLESS STEEL FASTENINGS
CASTLETON-ON-HUDSON, NEW YORK

New Materials and Equipment

window, and cool fluorescent lights do not cause abrasive to bake on the glass, thereby cutting out illumination.

Intended to perform work for which dry blasting is too severe, namely work with thin edges and sharp corners or work needing precision cleaning, the unit has cleaned successfully all sorts of dies, bottle molds and rubber molds.

New Finishing Process Designed to Meet Critical Nickel Shortage

Availability of Lea Copper-Glo solution for bright copper plating has been announced by *Lea Manufacturing Co.*, Waterbury, Conn. This process is said to make possible the obtaining of certain desirable finishes without the need of nickel plating as an intermediate step, which was formerly required. Copper-Glo also makes it practicable to plate prefinished steel and die-castings directly with chromium (over bright copper) without any intermediate buffing operation.

The Ronal process which uses the new product is an improved method for depositing a mirror-bright copper even at high current densities and at 100% efficiency with high throwing power. Deposits obtained from this bath are claimed to be comparable to bright nickel in brightness and are thus an ideal coating for zinc die-castings prior to nickel, brass or chromium plating. The deposit is ductile and bright for all thicknesses of plate and has excellent adhesion to the base metal. On steel, where it may be desired to flow the deposited copper to remove or hide scratches or polishing marks, the process provides an ideal coating.

According to the company, the solution will deposit mirror bright deposits at a current density range of 10 to 60 amp per sq ft with standard cathode rod agitation. Operating temperature range is broad, from 140 to 160 F.

Twin Column Punch Presses Eliminate Die Sets

New twin column punch presses which can be used for all types of blanking, forming, drawing and bending have been announced by *Wales-Strippit Corp.*, North Tonawanda, N. Y.

Hole punching and notching equipment is said to be used very efficiently on these

For BETTER CASTINGS

from First Design to Final Check . . .

Call on
ECLIPSE-PIONEER
Foundries

**ALL Aluminum and Magnesium Alloys
Including the recently developed
Cerium and Zirconium Magnesium Alloys**

When you order castings from the Eclipse-Pioneer Division Foundries, you *know* they will be right. Your confidence is justified at *every step* in their manufacture, from first design to final check, for each man is an expert in his field and each operation is backed by more than twenty years' experience. But, this craftsmanship is only part of the picture. As a further guarantee of quality, the Eclipse-Pioneer Foundries use the most modern machines, techniques and testing devices obtainable . . . the entire production line is conveyorized to assure rapid and economical service on all orders. Take advantage of these extras. If you plan to use aluminum and magnesium castings, make it a point to consult Eclipse-Pioneer. Meanwhile, send for Eclipse-Pioneer's "Book of Facts".

PLEASE SEND ME THE ECLIPSE-PIONEER *"BOOK OF FACTS"* ON MAGNESIUM, ALUMINUM AND BRONZE CASTINGS.
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COMPANY ____________ STREET ____________

CITY ________ ZONE ________ STATE ________

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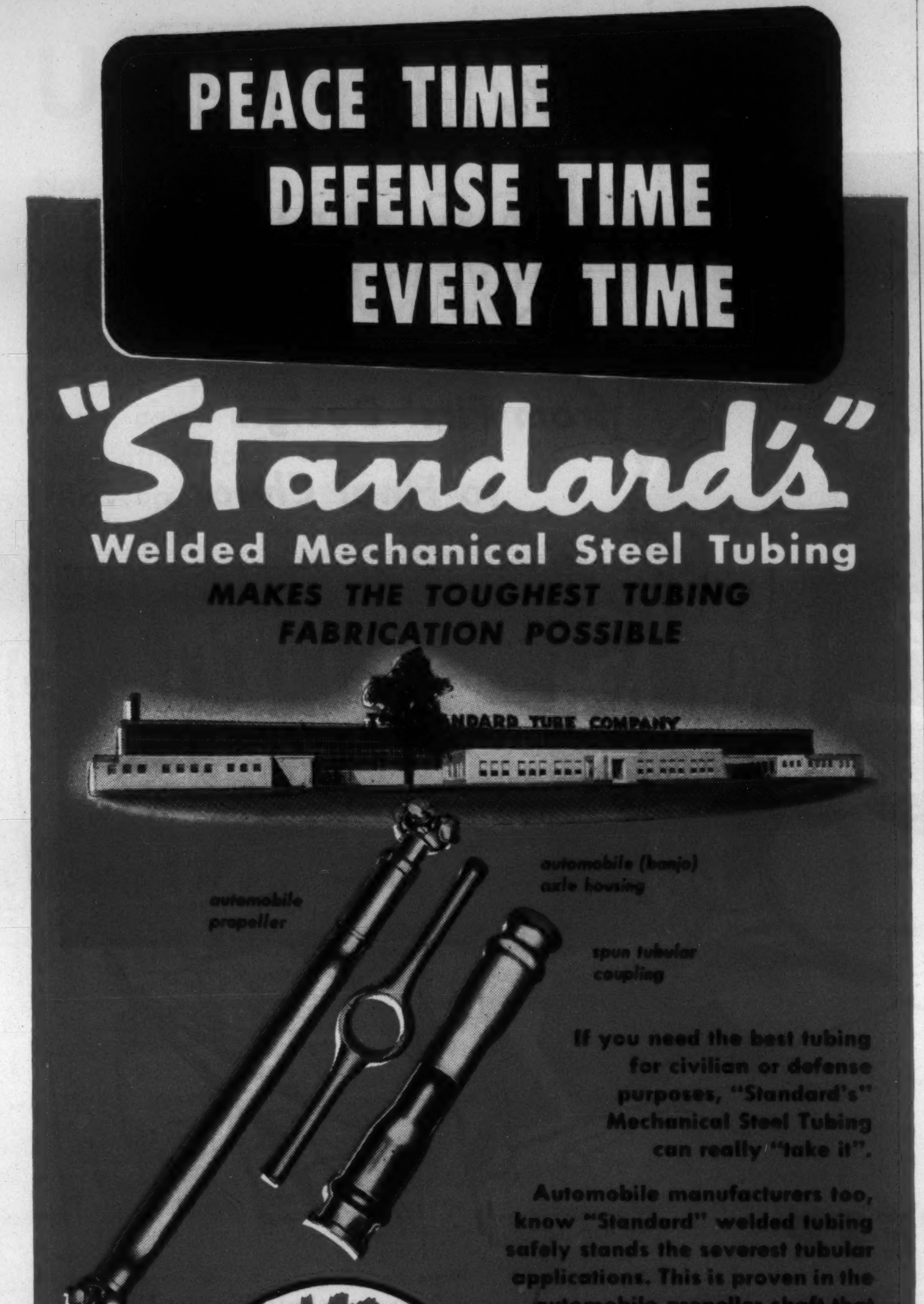
TETERBORO, N. J.
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

Bendix
AVIATION CORPORATION

AND PRECISION (±.005")

PLASTER MOLD
CASTINGS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DEFENSE TIME
EVERY TIME

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Welded Mechanical Steel Tubing
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If you need the best tubing for civilian or defense purposes, "Standard's" Mechanical Steel Tubing can really "take it".

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Peace time, defense time, every time—"Standard's" modern facilities, and 25 years of tubing know-how, assure you the highest quality tubing available.

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Welded Tubing Fabricated Parts
STANDARDIZE with "STANDARD" — It Pays

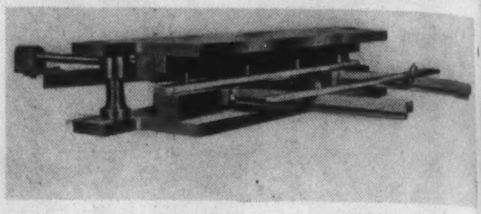
CARBON STEEL TUBING
½" O.D. to 5½" O.D.
.028 to .260 wall

STAINLESS STEEL TUBING
⅜" O.D. to 3" O.D.
.028 to .095 wall

New Materials and Equipment

rugged, versatile presses, while a self-contained shearing attachment is available as optional equipment for precision shearing.

Due to the similarity of design between the presses and a standard die set, these new units, in many cases, eliminate the necessity of die sets. Another advantage of the presses is their accurate and practical design features. A cylindrical pair of ram guides, 4 in. in dia, precision ground, highly polished and positioned vertically at exactly 90 deg reduce possible wearing to an absolute minimum. A rapid action 4-point clutch with a sliding clutch dog provides smooth rapid action for high-speed production. Herringbone bull gear and pinion gears provide quiet, smooth operation due to precision tooth spacing and the maximum number of teeth continuously in mesh. Extra large bearing areas on crankshaft distribute pressures and loads which result in minimum wear and friction loss, and an exclusive dual purpose clutch counterbalance supplements the conventional friction-type brake which is installed on the end of the shaft.


This self-contained shearing die attachment is easier to set up in the twin column presses than most conventional dies.

Automatic Metallizing Equipment Lowers Costs

Designed and built for specific production applications by *Metallisation, Ltd.*, of Dudley, England, fully automatic metallizing equipment is now available in this country through *Dix Engineering Co., Inc.*, 1415-17 Dix Rd., Lincoln Park, Detroit, Mich.

Illustrated is a section of one of several automatic units in daily use on varying applications. In this case, 2-in. dia scaffold pipe is being blasted and metallized with pure aluminum 0.004 in. thick at a speed of 1200 lineal ft per hr. More than 40 ft long, this machine is said to be so effectively controlled that only two men are needed for its efficient operation. Extremely low cost of operation results, in this instance, in a total cost of less than 10c per sq ft for both blasting and metallizing.

Now that metal spraying has been developed to the stage of being fully automatic for production purposes at economical costs, the field for metallizing

PRESSING . .

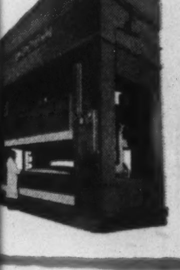
out the ARMS for UNCLE SAM!

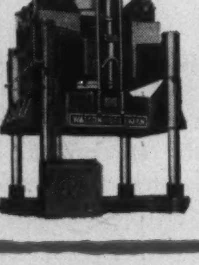
Planes . . . tanks . . . guns . . . shells . . . shell cases or any one of a thousand and one other items that must be produced, as long as it can be pressed out of metal, there's a W-S Press to do the job . . . and more economically, too.

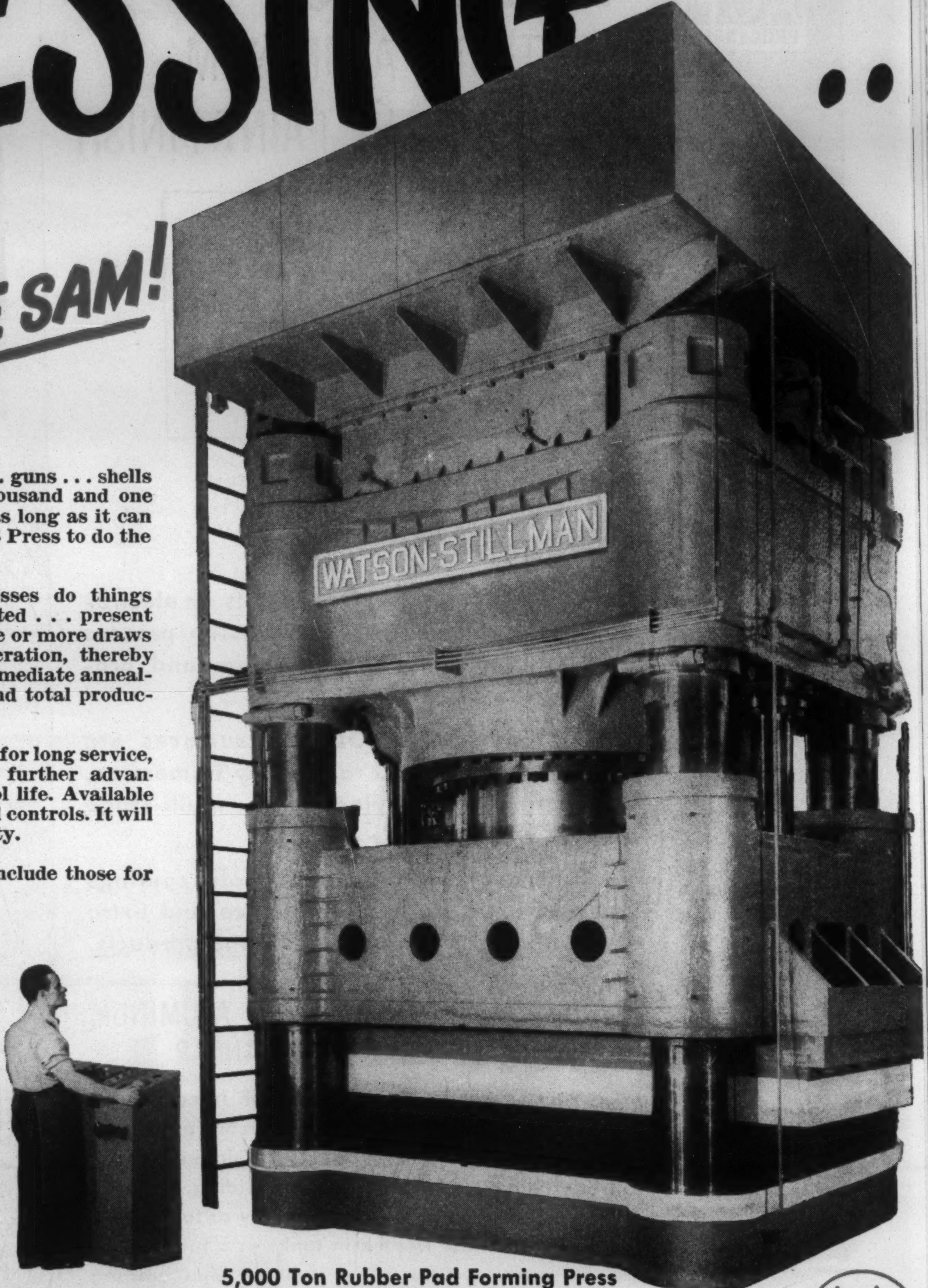
W-S Medium and Deep Draw Presses do things faster. Rejects are virtually eliminated . . . present dies and materials can be used . . . one or more draws may be cut from a progressive operation, thereby saving man hours on the job . . . intermediate annealing is often reduced or eliminated and total production time cut down.

Designed for precision work and built for long service, these W-S Hydraulic Presses offer further advantages in set-up, maintenance and tool life. Available in a large choice of pumping units and controls. It will pay you to investigate their flexibility.

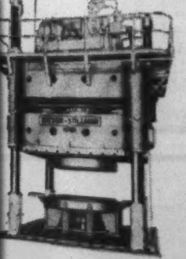
Other W-S Metal Working Presses include those for Forming, Flanging, Trimming, Forging, Coining, Hobbing, Extruding, Briquetting, Bending and Straightening.

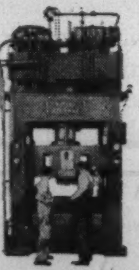






5,000 Ton Rubber Pad Forming Press





HYDRAULIC MACHINERY DIVISION

WATSON-STILLMAN Established 1848

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Los Angeles 11, Cal. . . . . H. M. Royal, Inc.
Pittsburgh 19, Pa. . . . . Stanley Berg & Co.
Portland, Ore. . . . . Machinery & Tool Supply Co.
Rochester 12, N. Y. . . . . . . Watson-Stillman Co.
San Francisco 7, Cal. . Schellenbach Mach. Tool Co.
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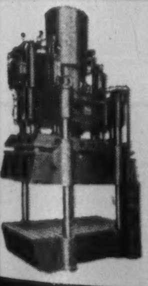

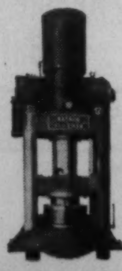

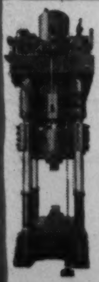

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W-S "COMPLETELINE" HYDRAULICS . . . THE SHORTEST DISTANCE FROM PRODUCTION TO PROFIT

CHEMICALS
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PROCESSES

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PROTECTS ALUMINUM
ANCHORS THE PAINT FINISH

MEETS GOVERNMENT SPECIFICATIONS

MIL-C-5541	U.S. Navord O.S. 675
MIL-S-5002	16E4 (Ships)
AN-F-20	U.S.A. 72-53 (See AN-F-20)

AN-C-170 (See MIL-C-5541)

EFFECTIVE, ECONOMICAL
EFFICIENT

ALODIZING is an electroless protective surface conversion process for bonding paint to aluminum and protecting the metal.

Tough, durable ALODIZED surfaces are obtained easily and rapidly by immersion, brushing, or spraying in a multi-stage power washer.

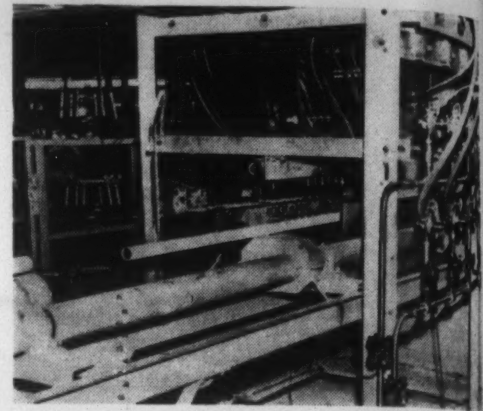
ALODINE amorphous phosphate coatings provide extra paint permanence and extra durability for aluminum parts and products.

BRUSH "ALODINE" PROTECTS ALUMINUM IN THE FIELD, SHOP, OR HANGAR

Brush ALODINE is easily applied in a simple brush-on or flow coat process to large assemblies and surfaces—airplanes, trucks, trailers, boats, housing, building siding, railway cars, bridges, etc.—that are too bulky or too remote to be conveniently treated in tanks or a multi-stage power spray washer. The cleaning and coating chemicals for Brush ALODIZING are shipped in bulk or in the convenient Brush ALODINE Chemical Kit No. 1. This Kit contains enough chemicals to treat about 1,000 square feet of surface and is an ideal package for use at airfields of commercial airlines or of the Armed Services anywhere.

ACP
Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
AMBLER, PA.
Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

New Materials and Equipment



Here, a 2-in. dia scaffold pipe is being blasted and metallized with pure aluminum 0.004 in. thick at a speed of 1200 lineal ft per hr.

by manufacturers is now virtually unlimited.

All ferrous and nonferrous metals produced in wire form can be applied by metallizing to a wide variety of products, including all metals, glass, wood, paper, ceramics, carbon and many plastic base materials.

Improved Molding Compounds Offer Added Strength and Resistance

What is claimed to be a radical improvement in molding compounds developed to give added strength and chemical resistance over present compression and transfer molding compounds has been announced by *Flexfirm Products*, El Monte, Calif.

Called Dryply Pre-Imp, because it is a polyester pre-impregnated glass fiber compound, the new development presents to molders a polyester resin with the uniformly distributed fiber content usable in present molding techniques.

The new material is claimed to combine the exceptional chemical resistance of polyester resin with the high impact, physical strength and heat resistance that only glass fibers can impart.

Packaged and ready for use in standard compression and transfer molding techniques and equipment, the new product has a shelf life of six months or longer at normal room temperature.

Lacquer Heater Useful for Small Batches

Said to be ideal for the job paint shops, automotive dealer paint departments, paint salesmen and paint laboratories, and par-

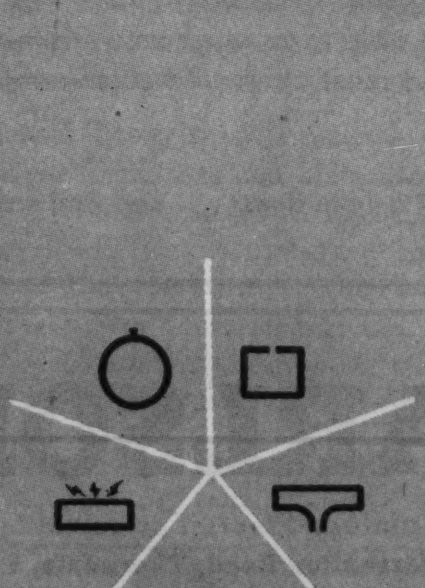
Van Huffel
cold-formed metal tubing
and shapes solve problems
for the makers
of

farm equipment

It may be a far cry from vegetables to Van Huffel, but farm equipment manufacturers will tell you they are both basic in the scheme of things.

For instance, where deadweight must be cut from a tractor without sacrificing strength . . . where a farm implement must be easier to carry, move or lift without complicated fabrication . . . a lot of production problems are being solved by the versatility of Van Huffel metal shapes and tubing.

VAN HUFFEL
TUBE CORPORATION • WARREN, OHIO



WELDED, LOCK SEAM, OPEN SEAM, BUTTED TUBING, SHAPES AND MOULDINGS

SEVEN
SURE
WAYS
TO

S-T-R-E-T-C-H
STAINLESS STEEL

1 Tell your supplier the end use as well as priority rating. This saves time.

2 Order only what stainless you need—to exact size.

3 Choose an alternate analysis, where possible.

4 Lay out a job for best use of material. Where possible order plate items cut to pattern. This keeps offcuts available for someone else—which may be you on your next requirement.

5 Plan far enough ahead so your supplier can schedule your properly rated order—and make a delivery promise that can be met.

6 Clean out your scrap pile—segregate stainless scrap as you accumulate it. Get it back to work.

7 Recognize the fact that the control of nickel limits the number of stainless plates that can be rolled—and that we at G. O. Carlson, Inc., like to say "yes" just as you do, but we aren't able to as often as we like—even to some of our oldest and most cherished customers.

Stainless steel is our only business . . . and we know it.

G. O. CARLSON, INC.
Stainless Steels Exclusively
200 Marshalton Road, Thorndale, Pa.
PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)
District Sales Offices and Warehouse Distributors in Principal Cities

ticularly for touching-up equipment originally finished by the hot-spray process, the new lacquer heater manufactured by *Thermalcup, Inc.,* Cleveland, features quart size capacity and fits all standard cup guns.

A new type heating element gives even heat throughout the cup. Working temperature is reached in 8 to 14 min, depending on the thermostat setting. Accurate temperature settings are available to suit specific requirements. The cup is noncorrosive welded spun aluminum, 7¾ by 4¾ in., and weighs only 25 oz.

Like the larger heaters, the new unit provides all the desirable features of hot-spray finishing, including: improved quality of finish; fewer coats needed; labor savings; savings in thinners; reduced rubbing and polishing; absence of blushing troubles; and better protection of surface.

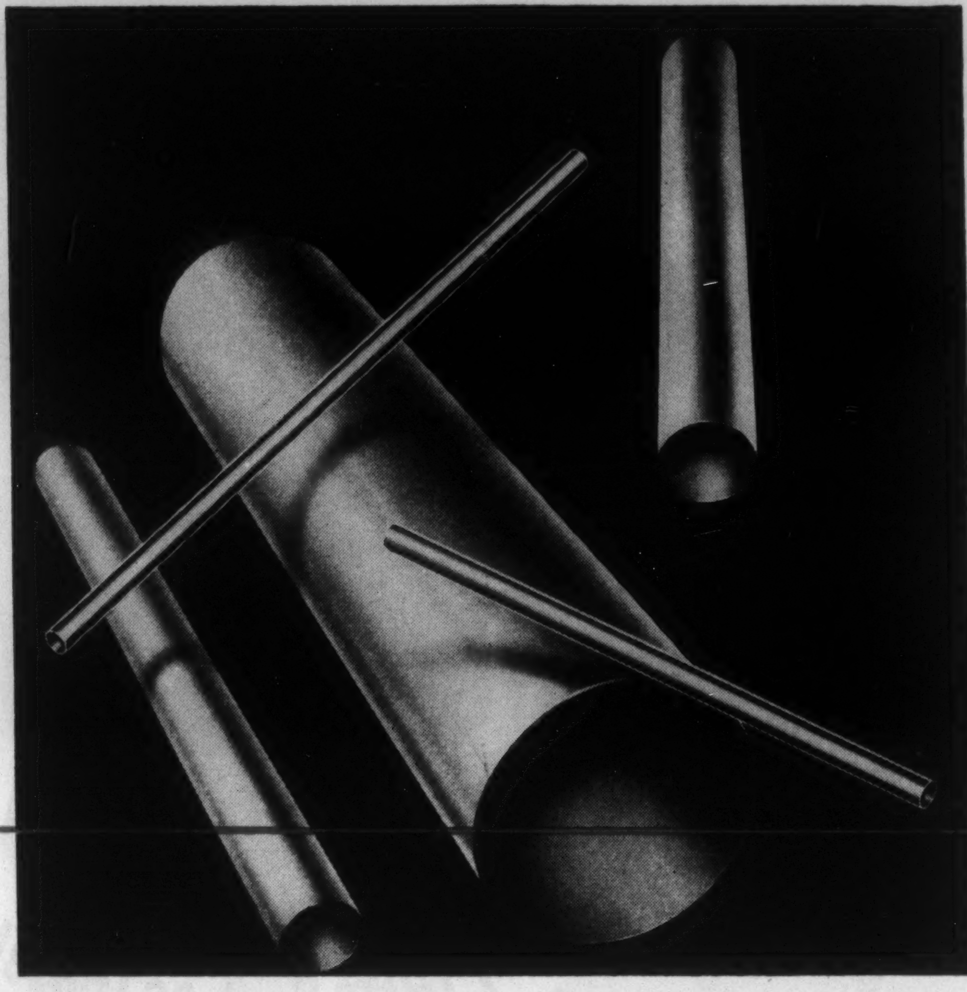
Low Cost Precision Stampings

The Mohawk Manufacturing Co., Middletown, Conn., has announced the production of small precision stampings held to closer tolerances and specifications than ever before possible.

By a new company process, holes in the pieces can be tapped, reamed, countersunk, etc. during the stamping operation, thereby eliminating costly secondary operations. Tapped holes, even off center holes, can be held to Class 3 Thread Fit.

These small precision stampings have been reported to be held to closer tolerances and specifications than ever possible before.

The prime advantage claimed for the process is that because of the superiority of the stamped parts, rejection of finished assemblies due to faulty components is virtually eliminated, with a resultant saving in cost and labor.



where stainless steel tubing

is required –

TRY TRENTWELD

Stock lines in food, paper, and chemical plants; heat exchanger units in processing industries; cooling coils in breweries, beverage industry, dairies and dairy equipment . . . throughout all industry, wherever there's a stainless or high alloy tubing application, there you'll find TRENTWELD.

And it's to be expected! TRENTWELD is made in a *tube* mill by *tube* engineers who roll and weld stainless and high alloy tubing *exclusively*. Then too, TRENTWELD is available in a full range of sizes — 1/8" to 36" in diameter. This coupled with Trent's convenient mid-continent location means prompt delivery of what you want . . . when you want it. If yours is a stainless or high alloy tubing requirement: Call on us. TRENT TUBE COMPANY, *Subsidiary of Crucible Steel Company of America.* General offices and plant: East Troy, Wisconsin; Sales offices in principal cities.

TRENTWELD

STAINLESS STEEL TUBING

We may
KNOCK
YOUR HAT
OFF

with our Quote on SAVINGS and DELIVERY

If you're a Big User of Tiny Parts Such as These!

Sound like exaggeration? Not when you know that the electronic tube industry looks to The Bead Chain Mfg. Co. for its millions of radio tube pins. Or, that builders of electrical apparatus turn to us for the contact pins, terminals, jacks and sleeves required in tremendous quantities.

For pin-like parts, and variations of bushings needed for *mechanical* purposes, as well, we are the money-saving supplier to scores of famous makers of products like toys, business machines, appliances, ventilators.

You save . . . if we can make it! We can almost say with certainty that if we can make that part (*up to ¼" dia. and to 1½" length*) you use in large quantities, we can show you a big saving. And, assure on-time deliveries to meet your defense work schedules! We have something unique back of that claim . . .

Nobody has What We Have! To be able to produce our famous Bead Chain to sell for pennies per yard, we had to develop *our own* equipment and method . . . our Multi-Swage Method.

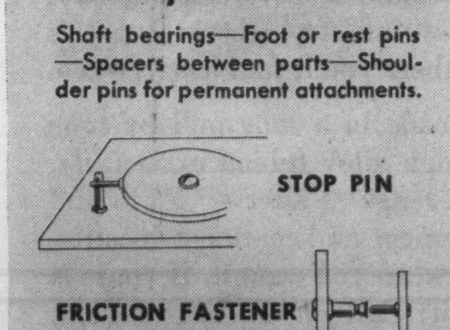
Instead of turning and drilling parts from solid rod, or stamping and forming them, our Multi-Swage Method automatically swages them from flat stock into precision tubular forms, with tight seams. By increasing the production rate many times and eliminating scrap, this saves a large part of the cost by other methods.

What We Can Make. Parts may be beaded, grooved, shouldered, and of most any metal. Generally, should not exceed ¼" dia. or 1½" length. Catalog shows many *Standard Items* available in small quantity. *Special Designs* must usually be ordered in lots of a half-million or more, unless they are frequently reordered.

Get Cost Comparison. Send blueprint or sample and quantity requirements. We will return an eye-opener on economy.

Low Cost Way to Get Parts for Many Mechanical Uses

Shaft bearings—Foot or rest pins—Spacers between parts—Shoulder pins for permanent attachments.



Let BEAD CHAIN make it by

MULTI-SWAGE METHOD

I want this Catalog — Data Folder

The Bead Chain Mfg. Co.
15 Mountain Grove St., Bridgeport, Conn.

Name, title..

Company..

Address..

Discussion of the Article "White-to-Grey Tin Formation in Refrigeration Equipment"

The transformation of white-to-grey tin at low temperatures has evoked considerable interest during the past few years because of the requirements of materials for applications in Arctic areas and in the stratosphere. The article by Mr. Kalish in MATERIALS & METHODS, *Aug. 1951, p. 136, resulted in an exchange of letters which we are publishing as additional clarification of this subject.*

August 31, 1951

To the Editor:

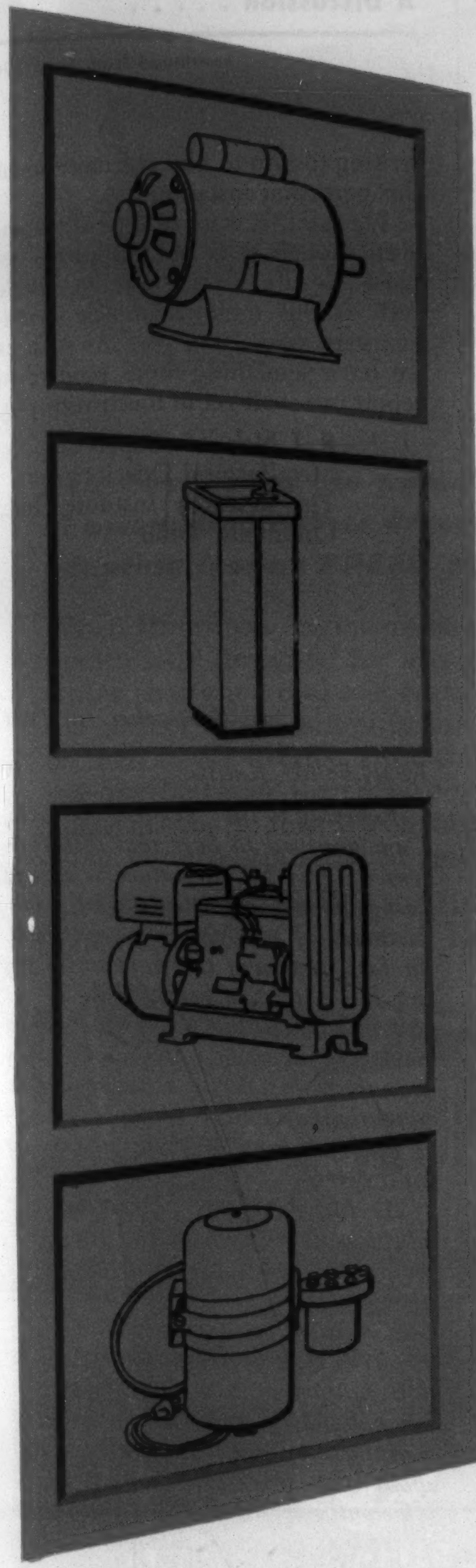
We have read with interest Mr. Kalish's article, "White-to-Grey Tin Formation in Refrigeration Equipment," which appeared in the August issue of MATERIALS & METHODS. What troubles us particularly is his statement to the effect that the use of electrotin should perhaps be avoided in refrigerator evaporator applications.

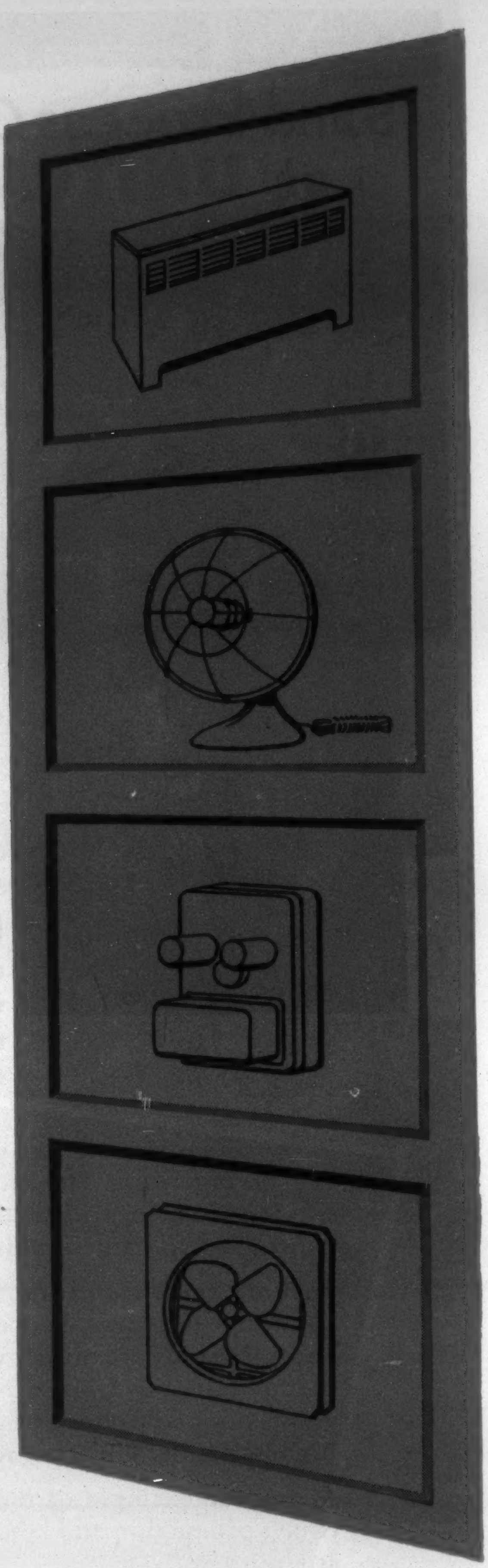
It happens that we have had a request for help from a large refrigerator company which has been faced with exactly this phenomenon. They have been able to trace the lot which failed through transformation to a shipment of "Vulcan" electro refined tin. As nearly as they can tell, they have not been troubled with white-to-grey tin transformation when ordinary fire refined anodes have been used. They have tried plating a trace of antimony along with tin, and this has stopped transformation.

We have been asked to find easy methods of plating traces of bismuth in the alkaline electrotinning process. It is our understanding that the tin fluoborate baths can easily be made to plate a trace of bismuth along with tin. This will stop transformation.

Dr. Higgs, of our English laboratory, believes that he himself acts as a carrier for grey tin nuclei. In no other way can he account for some of the transformations he has studied. Since Mr. Kalish had been working on transformation studies, it is entirely possible, as he suggests, that he had something to do with the transformations he reports. We are

(*Continued on page 138*)





For Everything Electrical

YOUR BEST
METAL CHOICE IS

HUSSEY

COPPER

AND

BRASS

Electrical conductivity . . . corrosion resistance . . . thermal conductivity . . . lifetime beauty — if your electrical products require one or more of these characteristics . . . your best metal choice is Hussey Copper or Brass. In your product, Hussey Copper assures versatile physical properties plus extreme ease and speed in forming and fabrication. Seven complete warehouses place Hussey Copper and Brass within easy range of your production.

Hussey Warehouses carry stocks of Copper and Brass Products

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1848-1951

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C. G. HUSSEY & COMPANY
(Division of Copper Range Co.)
ROLLING MILLS AND GENERAL OFFICES
PITTSBURGH 19, PA.

7 Convenient Warehouses to serve you

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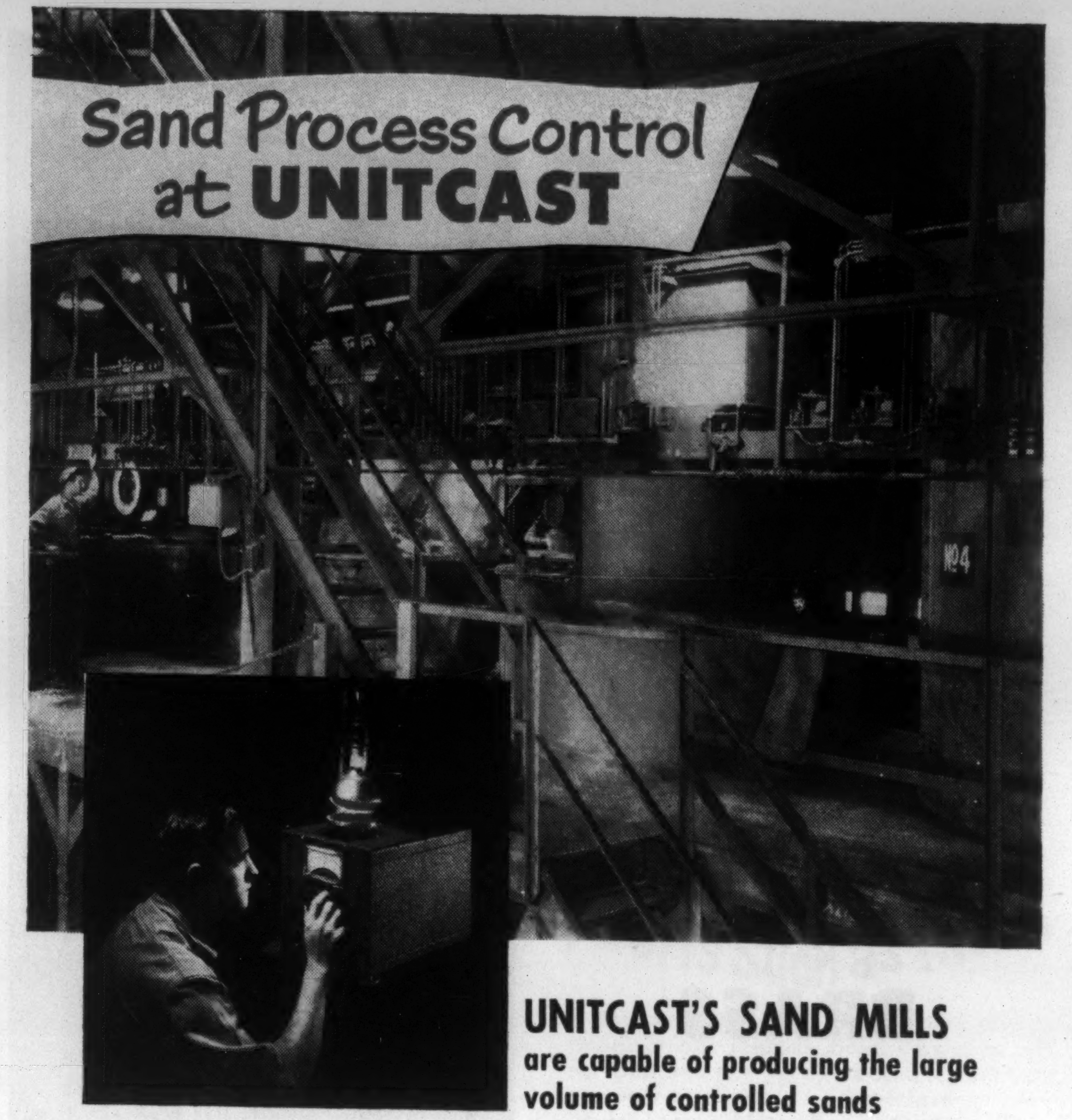
ST. LOUIS	1620 Delmar Boulevard
PHILADELPHIA	1632 Fairmount Avenue
CINCINNATI	424 Commercial Square



Sand Process Control at UNITCAST

UNITCAST'S SAND MILLS are capable of producing the large volume of controlled sands necessary to assure the production of top quality Unitcastings.

The new moisture tester pictured in use has an infrared drying lamp. The unit is a completely enclosed torsion balance, with dial calibrated directly in percentage of contained moisture.

Striking evidence of the adequacy of Unitcast's production equipment backed by continual laboratory control. Sands are milled with exacting care and thoroughly tested in Unitcast's completely equipped sand and testing laboratory to guarantee the production of highest quality Unitcastings.

A graphic example of the coordination existing between production and laboratory control departments at Unitcast.

UNITCAST Corporation QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

continued from page 136

writing to him to find out more about this particular instance.

We call this work to your attention, even though it is not complete, because we are afraid that an article such as this might stampede manufacturers away from tin. As soon as we have something more positive to report, we shall get in touch with you.

R. J. Nekervis, Supervisor,
Metallurgical Developments,
Tin Research Institute, Inc.,
Columbus, Ohio

September 14, 1951

Reply by Mr. Kalish:

Replying to Mr. Nekervis' remarks, I am gratified to hear that this problem of grey tin formation is at least being given some attention by manufacturers of refrigeration equipment. In fact, that was the purpose of my article. I was rather amazed to see this in a household refrigerator when it can be avoided. Obviously many manufacturers are not aware of the potentialities of this transformation—it takes a long time to appear in most cases.

As Mr. Nekervis points out, the addition of any of several trace elements can retard the transformation, bismuth being perhaps the best. But does it stop the transformation completely? It is unlikely that refrigeration equipment would be in service for a hundred years or so, and the manufacturer doesn't have to worry about the transformation if it is sufficiently retarded. The thing that is needed, however, is more definite knowledge about this transformation. What do the tin-bismuth, tin-antimony, tin-lead, etc. phase diagrams look like below room temperature? We have conjecture, but no definite information. Of the published work available, that of Cohen and van Lieshout is even today the only definite information we have. It is an outstanding contribution, but more is needed.

This tin transformation is unquestionably a difficult one to study because it is so slow. Reduce the transformation temperature with some additional element and it will take even longer. But how long? What do we really know about the carrying of

(*Continued on page 140*)

TINNERMAN
Speed Nut
Savings Stories

"NEW USE FOR FASTENER NETS *45% Savings*

SAYS HAMILTON MANUFACTURING COMPANY, TWO RIVERS, WISCONSIN

Hamilton "takes the water" out of cost of assembling clothes dryer drums by adapting crating SPEED NUT to new use

When Hamilton engineers saw the heavy duty SPEED NUT designed for attaching products to crates, they got a real cost-cutting idea. Here was the perfect way to simplify the tie-rod assembly on their dryer drums. They could see that trading one fastener for three could lead to lower material costs, less inventory and parts handling, and greatly reduced assembly costs.

All this is confirmed by the Hamilton Standard Department Cost Reduction Report No. 11. *The SPEED NUT method provided a 45% assembly savings—or nearly $1,500 total annual savings on this application!*

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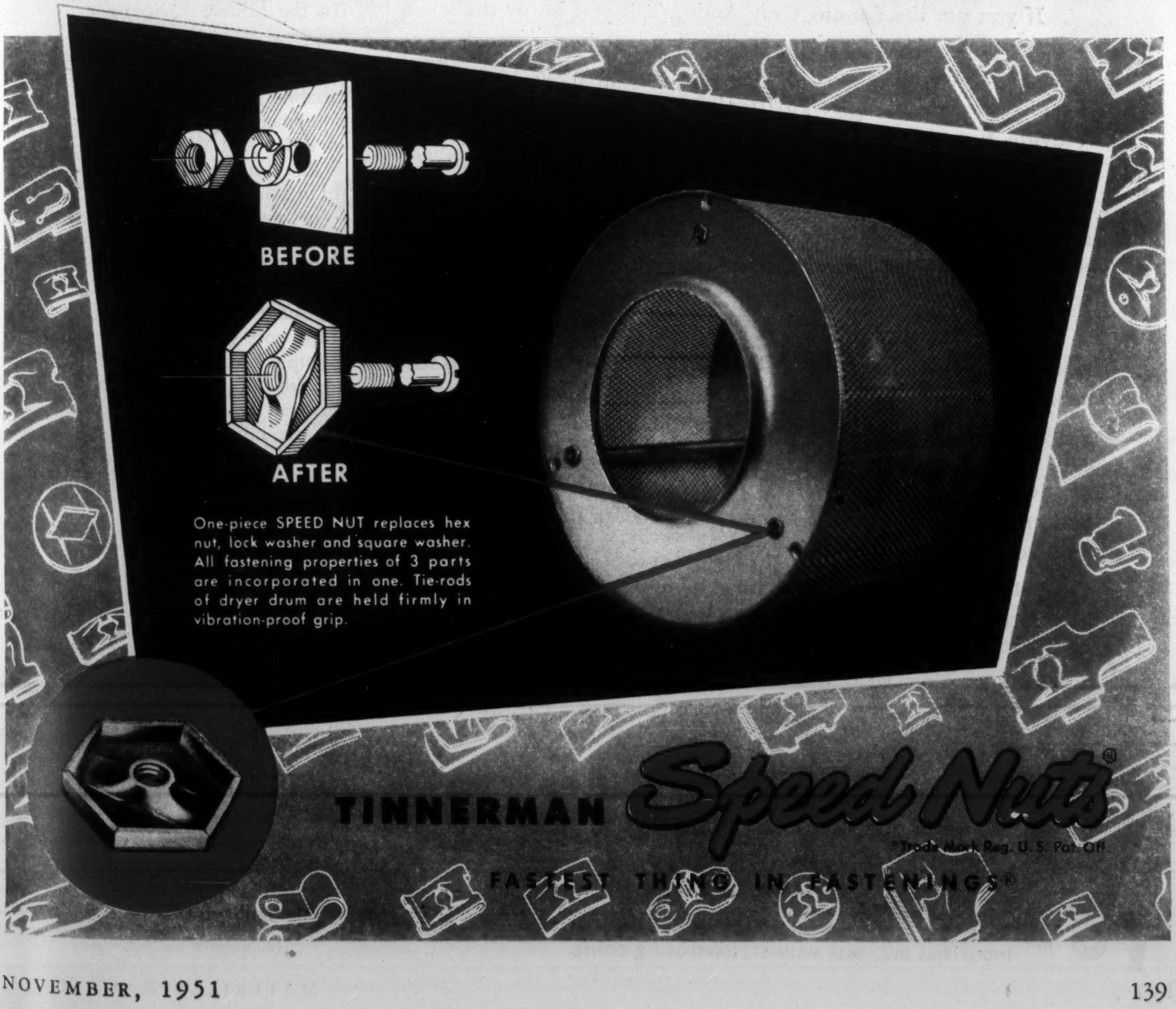
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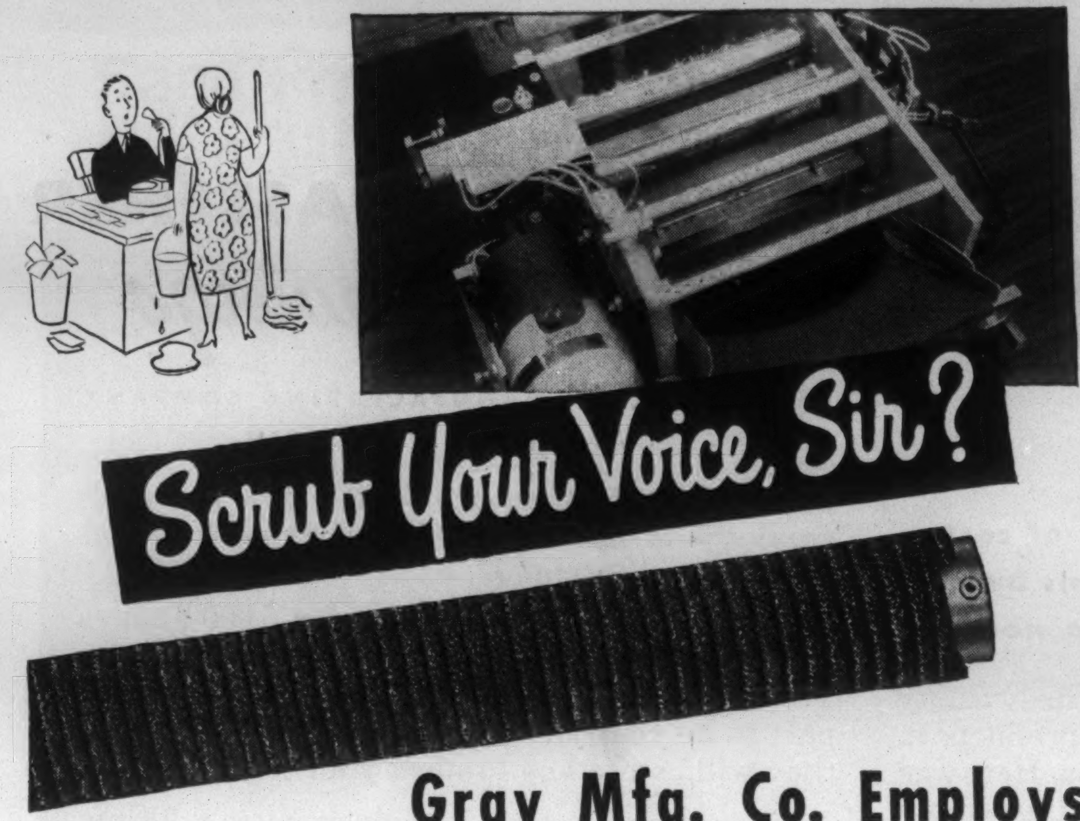

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If you use the famous Gray Audograph you know the used discs can be returned to the distributor to be processed for re-use. The machine which does this job is the Gray VoicEraser which, by scientifically applying heat to the Vinylite disc, causes it to return to its original smooth finish.

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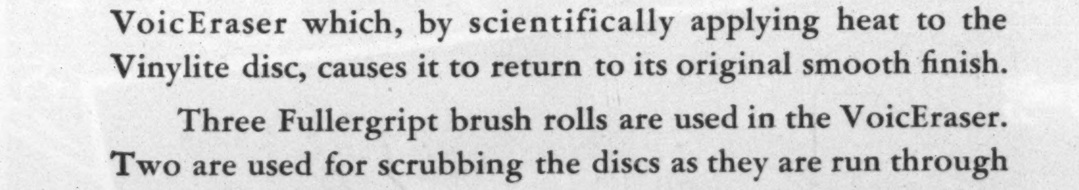


THE FULLER BRUSH COMPANY
INDUSTRIAL DIV., 3636 MAIN ST., HARTFORD 2, CONN.

continued from page 138

grey tin nuclei and how much these nuclei "seeds" are needed to start the transformation? It was our observation at the University of Pennsylvania that once we had made our first grey tin, subsequent transformations occurred throughout the laboratory with much greater rapidity. There is unquestionably some validity for the idea that these nuclei float around through the air and are carried from place to place by people and perhaps even in letters and on other objects. This is a fascinating facet to the subject.

Herbert S. Kalish,
Sylvania Electric Products, Inc.,
Bayside, L. I.

September 12, 1951

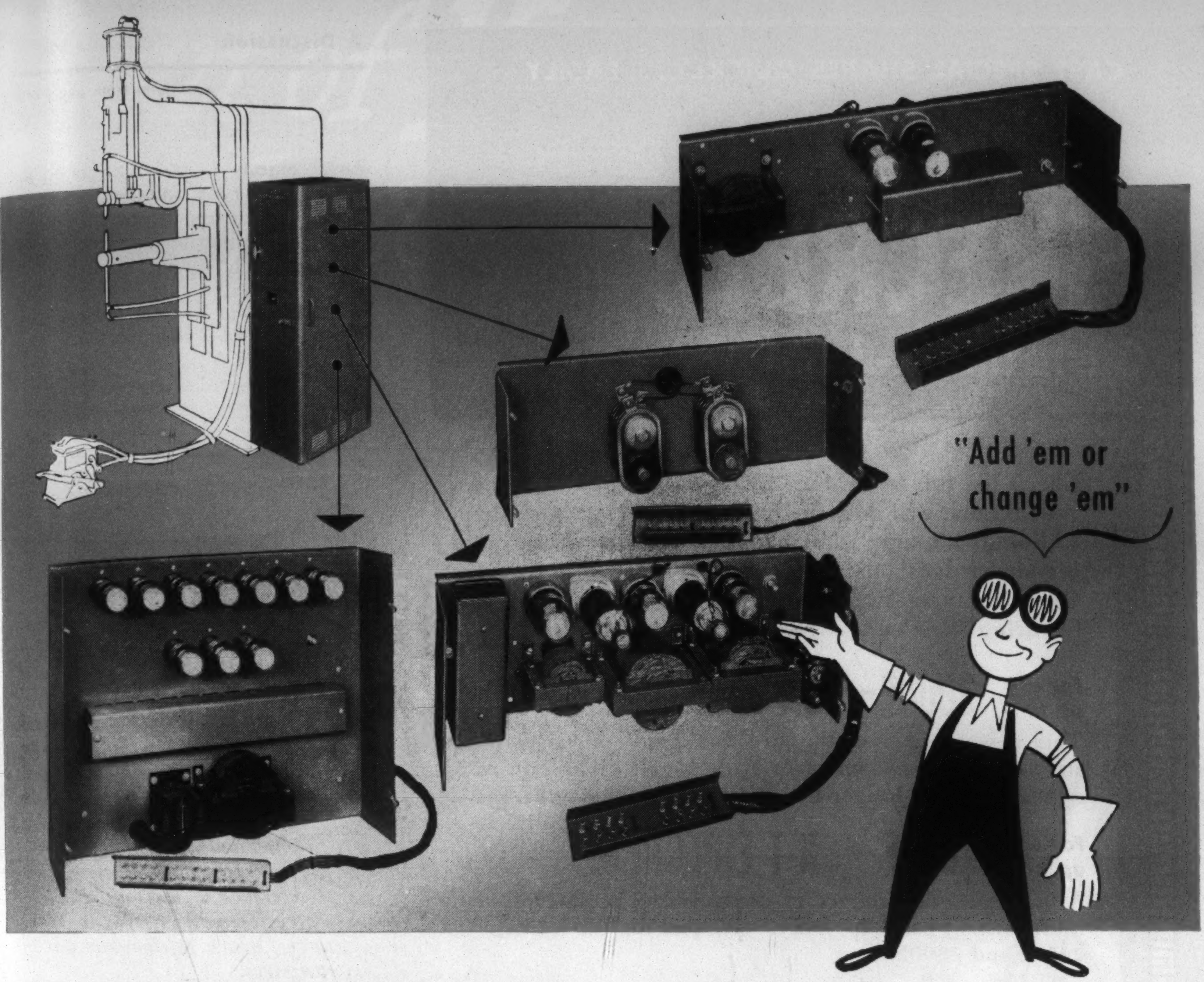
To the Editor:

On page 136 of the August issue the Sylvania people seem to be having trouble with tin in refrigeration equipment. It may be of help to them to know that the trouble is not due to the tin but to electroplating the tin in place.

In my article in METALS AND ALLOYS in Mar. 1945 on page 706 I wrote, "Another factor in soft soldering operations is that electrodeposited coatings are a questionable aid in soft soldering operations. For example, electrodeposited tin coatings are difficult to solder and the bond between the tin and copper is poor. On the other hand, hot tin dipped coatings are easy to solder to and the bond between the tin and copper is excellent."

We have had tin disintegration take place at normal temperatures when electroplated on the metal but not when hot tin dipped. That the low temperatures (at refrigeration temperatures) are not the cause may be seen in their own article, which says "soldered joints are used freely on many pieces of low temperature equipment without fear of failure." I wrote you once in reply to your questions that aside from notch brittleness, at the refrigeration temperatures, nothing was to be feared in soldered joints. This confirms their experience with soldered joints quoted above. The bond between electroplated tin

(*Continued on page 142*)



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FIRECRETE

"The Standard in Castables"

continued from page 140

metal objects is poor, as stated in my article in 1945, and the disintegration of tin at low temperatures and the disintegration of electrodeposited tin are entirely separate subjects.

A. Z. Mample, Asst. to Lines Engr.,
Western Union Telegraph Co.,
New York, N. Y.

September 24, 1951

Reply by Mr. Kalish:

Mr. Mample has several misconceptions about this particular application of tin. I shall attempt a clarification of these ideas.

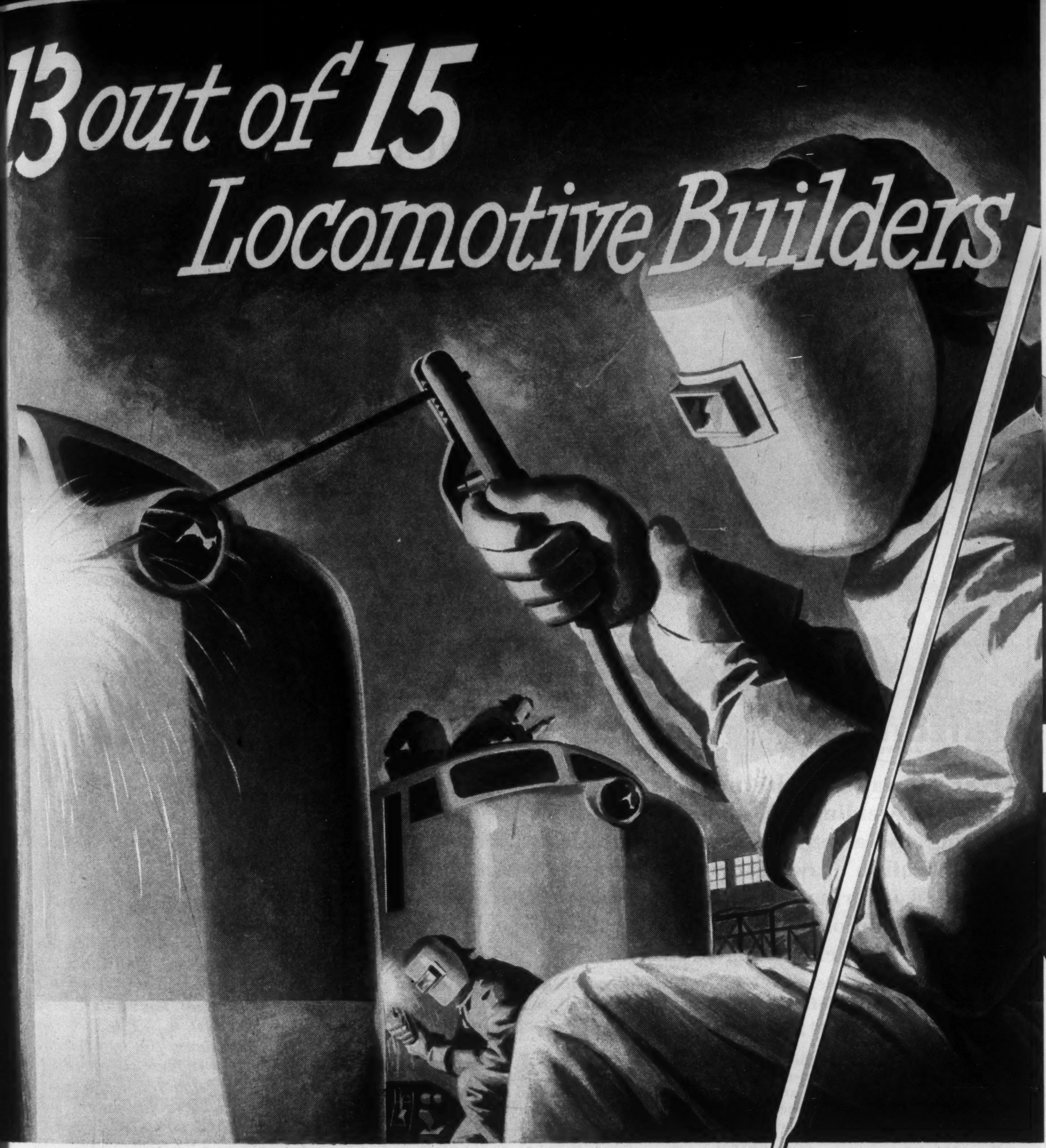
In the first place, Sylvania Electric Products, Inc. has nothing to do with this particular problem. They do not manufacture refrigeration equipment, and their use of refrigerators seems limited to those in the company cafeterias. The refrigerator I had reference to was one made by one of the foremost refrigerator manufacturers, which refrigerator was in my apartment.

As for this particular refrigerator and others produced at the same time, there seems to be some question in Mr. Mample's mind as to whether this was really the white-to-grey tin transformation. My examination of the refrigerator revealed the following:

1. *The disintegration of the plating was due to an obvious expansion of the plating and, necessarily, the forming of a powder. Such a phenomenon indicates a lattice expansion.*
2. *The powder, after being allowed to come to room temperature, took on a metallic appearance.*
3. *Spectrographic analysis of the powder revealed that it was tin of high purity containing absolutely no bismuth, less than 0.01% lead, and less than 0.01% antimony.*

These observations show that the tin had unquestionably transformed to the low temperature grey, a form. The high purity of tin indicates that it had been electroplated on, or if hot

(Continued on page 144)



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A Discussion . . . . .

continued from page 142

dipped (this possibly exists), the tin was probably electrolytic tin, accounting for its high purity.

The base metal of the cold chamber was steel. I do not venture to discuss the relative merits of electroplating or hot dip tinning either a steel or copper base. Soldering, per se, has nothing to do with this problem. Solders are used in low temperature applications. This is well known. No reports of solder failures due to the β to α transformation have come to my attention and I doubt that such transformation would occur in this millenium. The expansion of the lattice necessary for the transformation to occur would be hindered by the lead rich phase present even in addition to the effects the lead in solid solution might have upon lowering the transformation temperature. Even so, the transformation could occur in time because the tin-rich phase is the continuous one even in solders quite rich in lead. This means that there would be no bands of ductile material around the tin phase to prevent the expansion to occur. Pressure, of course, very much reduces the white-to-grey tin transformation temperature.

As for the question of low temperature embrittlement of solders, it is well to refer to the article "The Low Temperature Properties of Tin and Tin-Lead Alloys" by Kalish and Dunkerley[1]. Here it is shown that the embrittlement temperature of a 50% lead solder is —140C, so that applications above this temperature would be safe enough. If one needs to use solder below this temperature, it seems advisable to increase the lead content to 70% or more.

I would be interested in knowing more about the tin disintegrations Mr. Mample observed on electroplated objects at "normal" temperatures. The β to α tin transformation has been accurately determined by Cohen and van Lieshout[2] at 13.2C. This is not very cold. On the other hand, if these disintegrations are a mere flaking off of the plate due to a poor bond, it is very easy to distinguish from the white-to-grey tin transformation which was observed in this refrigerator.

H. S. Kalish

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[1] *H. S. Kalish and F. J. Dunkerley, "The Low Temperature Properties of Tin and Tin-Lead Alloys",* Trans. AIME, *1949, Vol. 180, p. 637.*

[2] *E. Cohen and A. K. W. A. van Lieshout,* Ztsch. Phsikal Chem., *1935, Vol. 173, p. 32.*

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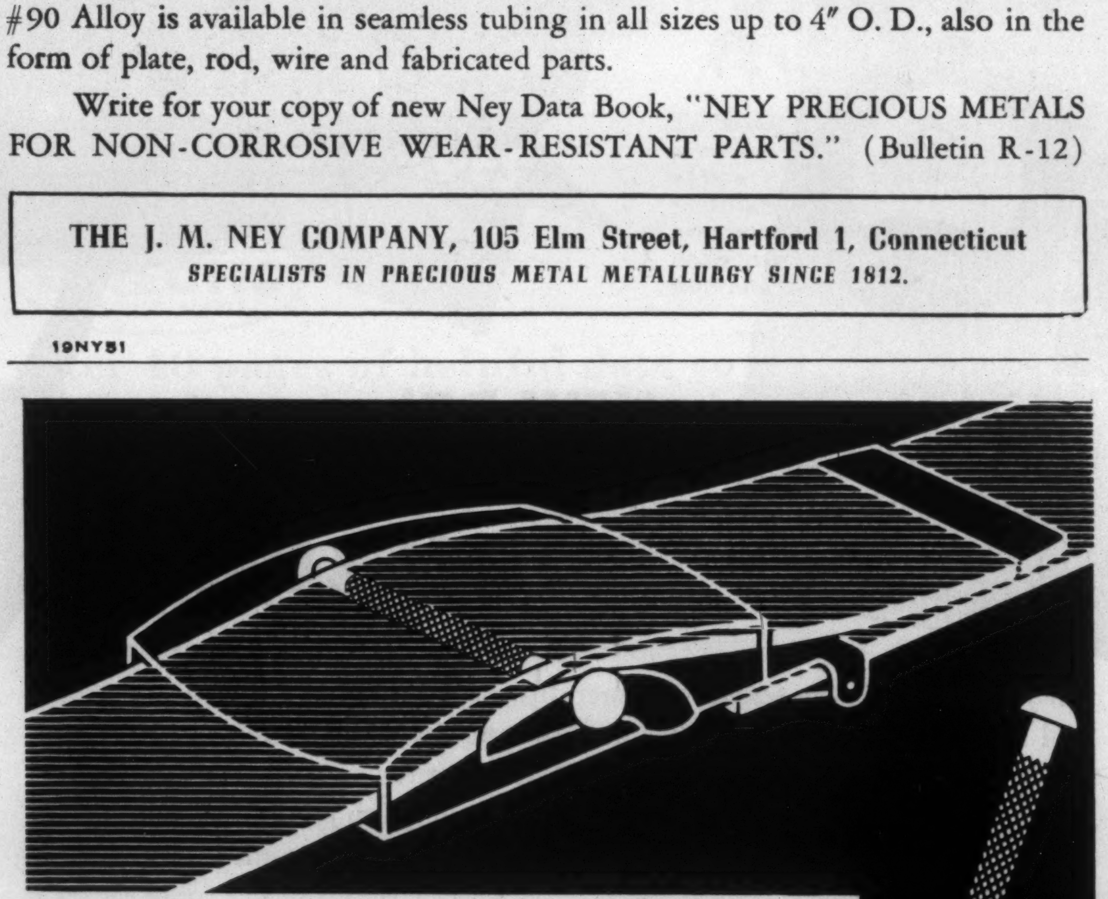

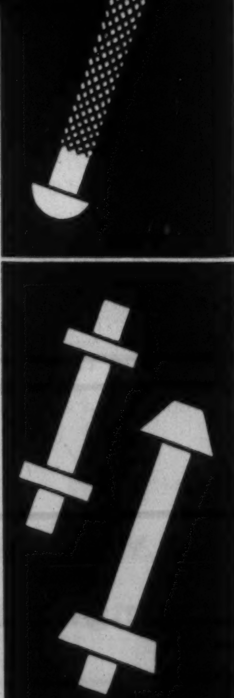

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News Digest

continued from page 13

deformation potentials of Bardeen and Shockley. The scattering is present in addition to the normal thermal scattering and is regarded as a perturbation in the Boltzmann equation. This perturbation is used to find the incremental resistance per dislocation. From this calculated increment in the resistance and the known increase of resistivity of heavily cold-worked copper, the number of dislocations in the cold-worked copper is found to be 5 x 10^{11} square centimeter, in agreement with the number estimated on the basis of stored energy measurements.

W. F. Brown, Jr. and George Sachs of the Lewis Flight Propulsion Laboratory discuss notch sensitivity in stress-rupture tests in Technical Note 2433. A critical review of the English and German literature on notch rupture testing was made to establish the influence of notching on various heat treated steels and several nonferrous alloys when subjected to long-time loading at elevated temperatures. A correlation between rupture ductility and notch sensitivity is established for low-alloy steels. Notch rupture data are compared with data obtained at room temperature to reveal the general effects of notch geometry. Notch embrittlement observed for low-alloy steels in rupture tests is discussed with regard to a precipitation reaction, and is correlated with the composition and heat treatment.

Malleable Iron Industry Celebrates 125th Birthday

The 125th anniversary of the malleable iron industry in the United States was observed by the Malleable Founders' Society in its September meeting in Cleveland. The first American malleable was made on July 4, 1826 by Seth Boydan, an American inventor in Newark, N. J. Malleable castings are made today by 100 companies in 113 foundries in 19 states and Canada. Nearly 40,000 workers produce more than one million lb of castings every year.

Besides its tribute to the growth of the industry, the meeting discussed

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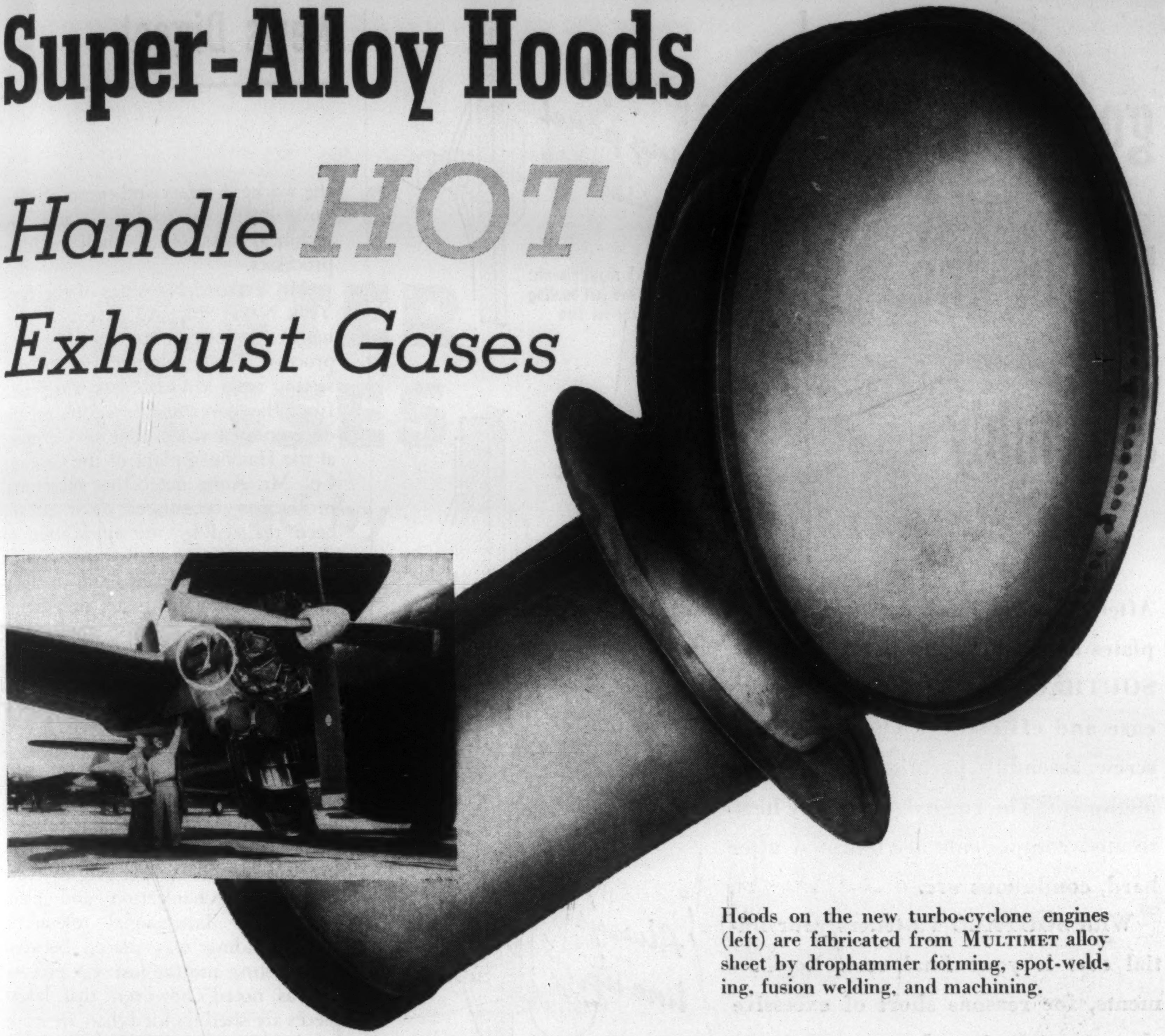

Hoods on the new turbo-cyclone engines (left) are fabricated from MULTIMET alloy sheet by drophammer forming, spot-welding, fusion welding, and machining.

Rugged hoods of MULTIMET alloy carry off exhaust gases from the turbo-cyclone engines on this latest version of the Navy's famous "Neptune." Each hood withstands the severe heat and stress from the exhaust of six of the 18 cylinders in the engines. The exhaust is compressed into a single stream, fed through a turbine, then passes off through the hoods.

One of the reasons why MULTIMET alloy was selected for this grueling service was because it had proved so successful in gas turbines. The alloy stands up under high stress at temperatures at which other metals buckle and crack.

Besides its many aircraft applications, MULTIMET alloy is also being used in heat-treating and cyaniding equipment and other key spots where heat and oxidation cause frequent failures of most metals. It is available in all standard cast and wrought forms and can be readily fabricated by most common methods. For complete information on properties and fabricating techniques, write for the booklet, "HAYNES Alloys for High-Temperature Service."

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the worker's safety and compensation, government restrictions, and the technical aspects of shell molding processes.

Mr. Bernard N. Ames of the New York Naval Shipyard gave a comprehensive report on the shell molding process. The development of thermosetting resin sand binders was traced from the government reports on the development work done in Germany at the Hamburg plant of the Croning Co. Mr. Ames noted that substantial production economies have already been realized by the application of shell molding to valve parts, gears and automotive castings and that ammunition components are now being shell molded. It was emphasized, however, that shell molding has its limitations.

In general, Mr. Ames concentrated on the production problems. He outlined the effect of sand particle size on the smoothness of the casting and gave a résumé of production techniques, covering investment mixing, pattern equipment, gating and heading, closing molds, backing up, core blowing, mechanization and plant safety. In dimensional tolerances, shell molding was placed between sand casting and the lost wax process. It was noted, however, that larger pieces are shell molded than are made by the lost wax technique, and that tolerances would probably be similar on pieces of equal size made by both methods. In malleable iron, tolerances of ±0.003 in. can be held in shell molding on fairly large pieces. The dimensional stability of the molds and their resistance to moisture and deterioration make their storage and shipment between plants practical, too, according to Mr. Ames, so that their use reduces duplication of master pattern equipment.

The physical properties of aluminum alloys, bronzes, malleable iron and ductile iron cast in shell molds are equal or superior to the properties obtained in green sand practice, according to the author. He took exception, however, to statements that steel shot backing acts as a chilling agent to improve soundness and permit better control of solidification trends.

Mr. Ames also gave his views on the economies of shell molding: "From an overall cost point of view, every job is obviously not suited for

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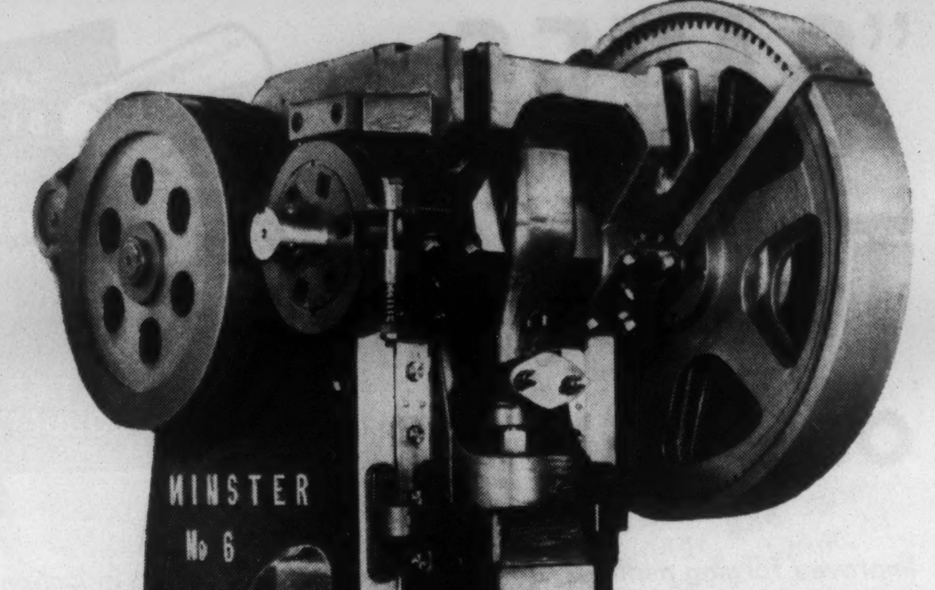

Nickel alloyed castings and forgings are used for vital components in the Minster line of mechanical power presses . . . which range from 12 tons to 1500 tons capacity.

THIS OPEN BACK inclinable press cuts handling costs. Not only can it deliver 60-ton pressure at the bottom of the stroke, but it permits a wide range of feed direction, parts ejection and scrap handling.

Moreover . . . to improve its performance and service life . . . the builder, The Minster Machine Company of Minster, Ohio, utilizes high strength nickel cast iron frames, nickel bronze bearings and forged nickel steel clutch parts.

Main frame and all component castings are produced in Minster's own foundry, from high tensile nickel alloy iron containing 0.90 to 1.75% nickel, depending upon use.

Ellwood City Forge Company of Ellwood City, Pa., forged all clutch throwout and striking parts from heat treated Type 2350 (3½% nickel) steel. This high carbon nickel steel provides stamina to withstand the high stress which occurs when the crankshaft accelerates from "idle" to "full speed" within a fraction of a second.

All bushing for crankshaft bearings, and for lower connection bearings are of 1½% nickel bronze . . . cast by Ryder Brass Foundry of Bucyrus, Ohio.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, nickel is obtainable for the production of engineering alloys for many end uses in defense and defense supporting industries.

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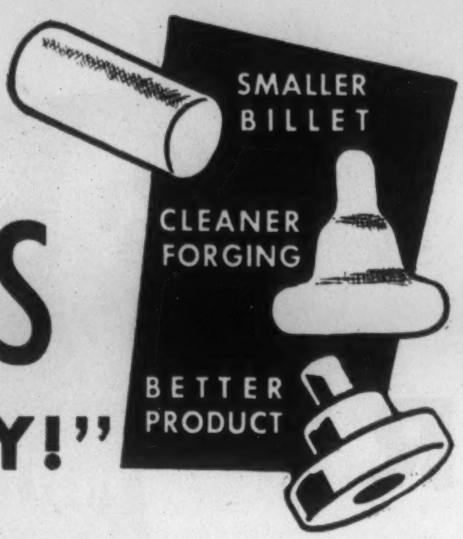

Improved forging methods, using scale-free Ajax-Northrup induction heat, have reduced billet weights for these axle spindle forgings from 7½ to 5¼ pounds.

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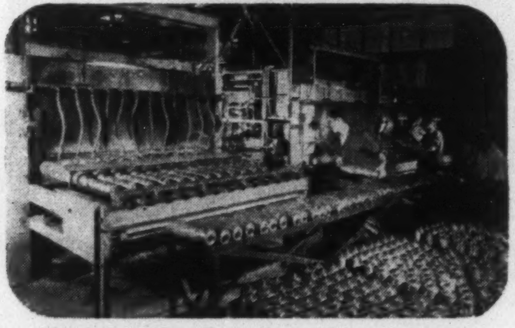
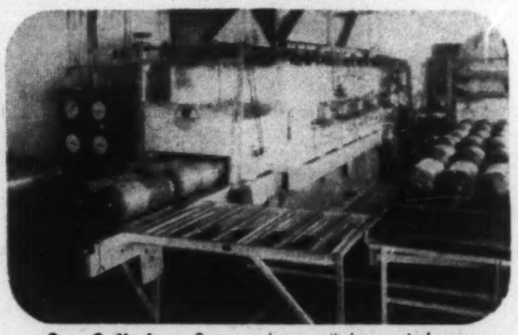


Shell Forgings 75 mm, 90 mm, 105 mm and other sizes are scale-free hardened, uniformly, automatically and continuously, in these and other EF gas fired installations.



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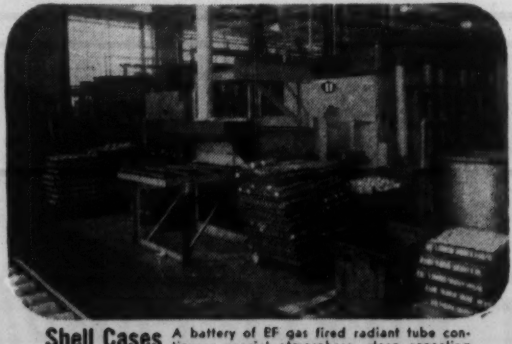


Shell Cases A battery of EF gas fired radiant tube continuous special atmosphere, clean annealing and stress relieving furnaces. Other types available for steel or brass.

News Digest

the shell molding process. For one thing, as long as metal patterns are still a requirement, tooling costs are high and several patterns and core boxes are required. Hence, the necessary volume is a basic requirement. Second, the design of the casting must lend itself to a suitable parting and gating and heading arrangement. And third, and possibly most important, is how much will be saved in the cleaning room and machine shop. No general rule for cost comparison with sand castings can be derived. Each casting must be examined on its own merits. The greatest economies to be gained obviously will be in the cleaning room and in the machine shop."

Golden Anniversary Book Summarizes 50 Years of U. S. Steel

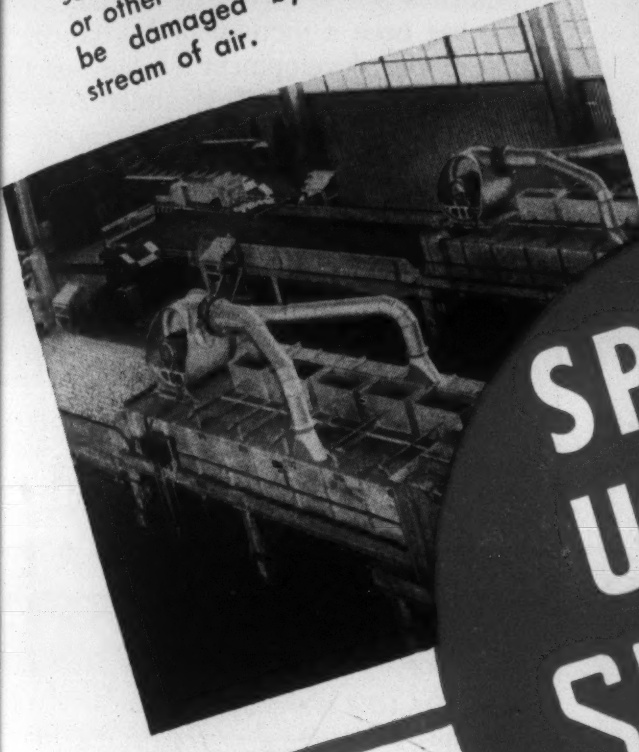
United States Steel Corp. is beginning to distribute its Golden Anniversary Book, *Steel Serves the Nation.* The 228-page volume summarizes the accomplishments and services of United States Steel since its formation in 1901. The book is graphically illustrated, with many new black and white and color pictures which show the men who have shaped the destinies of the Corporation and the advances that have been made in steelmaking during the last half century.

Steel Serves the Nation was written by Douglas A. Fisher, staff writer in the office of J. Carlisle MacDonald, assistant to the chairman in charge of Public Relations. In the preface, Board Chairman Irving S. Olds says: "United States Steel Corp. celebrates its Golden Anniversary this year with the satisfaction and pleasure that usually accompany the attainment of such a respectable age. Naturally, we are proud and happy to have rounded out half a century in business with a record of successful achievement in our field of industrial activity.

"Half a century is a short time in the history of a nation, but in the past 50 years scientific and industrial advances have completely transformed the everyday life of the average American. From the horse and

COOLING

Quenching, or reducing the temperature of heat treated materials is accomplished with Spencer low pressure air. Also ideal for cooling glass or other fragile material which might be damaged by a high pressure stream of air.



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Liquids up to 10 or 15 feet deep can be kept in constant motion by Spencer Turbos, delivering air at 5 to 7½ lbs. pressure. Supplies a clean source of air for yeast tanks; artificial ice plants; electroplating, and many uses in chemical or oil plants.

SPECIAL USES FOR SPENCER HARTFORD TURBOS

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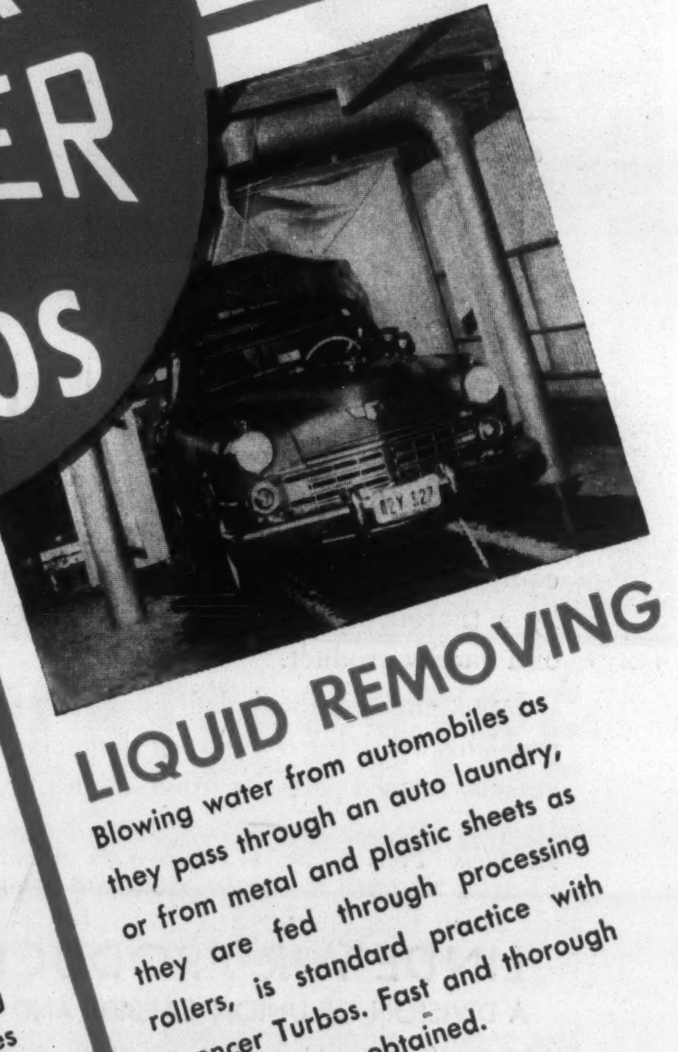
Dust can be removed from fast moving strips of steel or paper sheets as they pass by a slotted pipe or nozzle. Spencer blowers delivering high velocity air at low pressures give economical results.



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Blowing water from automobiles as they pass through an auto laundry, or from metal and plastic sheets as they are fed through processing rollers, is standard practice with Spencer Turbos. Fast and thorough results can be obtained.

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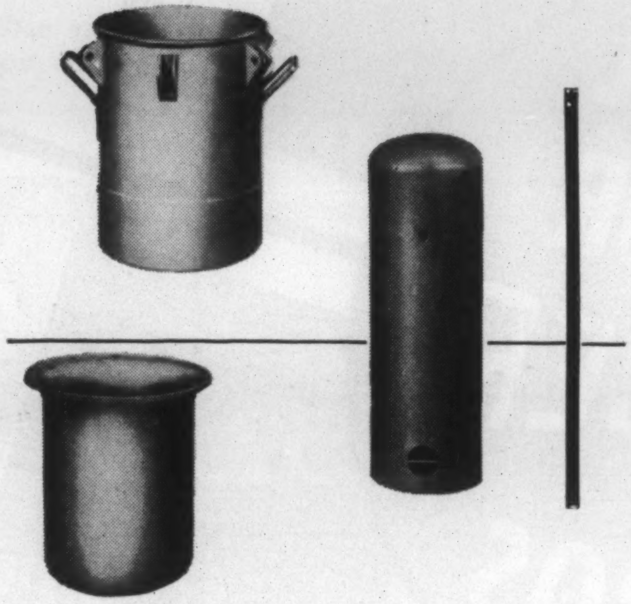

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buggy era we have progressed to a point where many products once considered inaccessible luxuries to most of our citizens are now regarded by them as ordinary necessities. This has been a monumental achievement in the development of our country. It was accomplished under a system of competitive free private enterprise, in which steel has played a major role as a basic metal."

Mr. Olds noted that from the beginning of operations on Apr. 1, 1901 to Jan. 1, 1951, United States Steel had produced more than 930 million tons of steel, which has been used in one form or another by practically every industry in the land. Directly or indirectly, he said, the Company's achievements have benefited millions of Americans in their daily lives.

Safety Men Honored by American Die Casting Institute

Chicago, Sept. 20—An outstanding step in the field of safety engineering in die casting plants received public acknowledgment today when the Annual Doehler Award of the American Die Casting Institute was presented to the authors of the "Safety Manual" for the Die Casting Industry.

The Doehler Award, established in 1949, is made each year for the outstanding achievement contributing to the advancement of the die casting industry. It was presented to Charles A. Sanford, industrial relations manager of the Cleveland Hardware and Forging Co., Cleveland; Norman Dress, personnel manager of Precision Castings, Inc., Cleveland; and Byron S. Van Horn, safety director of the Doehler-Jarvis Corp. These three men were directly responsible for the compilation and publication of the Die Casting Industry "Safety Manual."

A planned program to eliminate preventable accidents and industrial hazards is the direct goal of the "Safety Manual," which for the first time adapts general safety principles to the operations of the die casting industry.

Designed for use in both small and

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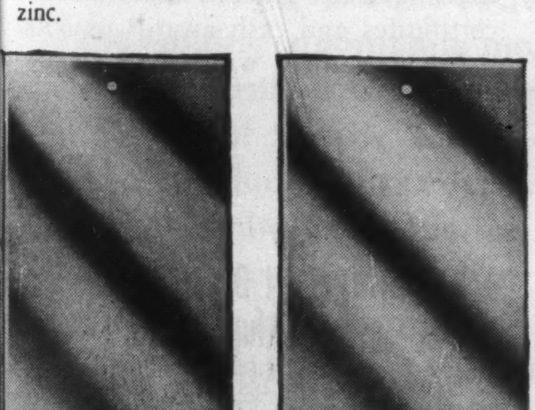
New Materials and Equipment

Clear Coatings for Zinc and Steel Stand 800 Hours' Salt Spray

Increased use of zinc die castings and of zinc-plated steel to replace unavailable materials, combined with the tight supply of copper, nickel and chromium normally used for plating zinc, has focused attention on surface coatings comparable to plating in service performance. Unbiased laboratory tests show that at least two of the clear finishes in the company's line withstand the exceptionally long period of 800 hours' exposure to salt spray and to weatherometer tests.

Effectively protect zinc

These tests demonstrate that DULAC Clear Universal Lacquer #462 and CODUR Clear Synthetic Y743 provide completely satisfactory protection on zinc, zinc plated steel and steel. Even after the unusually severe tests to which these finishes were subjected, there was no indication whatever either of failure of the coating or of discoloration of the zinc.



(Left) A zinc-plated steel panel newly coated with DULAC #462. (Right) A similar panel after 800 hours' exposure to salt spray, showing no evidence of attack on the finish.

Adaptability to Drying Schedules

While both finishes give the same performance, DULAC #462 is an air-drying coating, while CODUR Y743 is a baking type. This permits choice of the correct finish to fit into the drying schedules of a particular finishing room.

Technical Data Bulletin #110 on clear finishes is available from Maas & Waldstein Co., 430 Riverside Avenue, Newark 4, N. J. On request, M & W Technical Service Engineers will discuss specific problems.

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Technical Topics

12-14% CHROME TYPE ALLOY

Norman S. Mott

Chief Chemist and Metallurgist

This composition is a mildly corrosion-resistant alloy capable of being heat treated for a variety of properties including high strength and hardness. It has a low coefficient of expansion, is tough, machinable, weldable, and finds extensive use in valve bodies, valve trim, pump parts, grinding units, etc., especially in power plants, oil refineries, and paper mills. The alloy has suitable corrosion resistance for applications involving superheated steam, hot oil, foodstuffs, and some neutral salts; however, it will rust to a slight extent in a moist atmosphere. Its low cost, high strength, high hardness and wear resistance, coupled with an appreciable amount of corrosion resistance, make it an ideal alloy for specific applications where these factors are of primary importance.

This alloy is supplied in three carbon ranges: under 0.15% C, 0.15 to 0.25% C, and 0.25 to 0.35% C, these being designated as CA 14S CA 14I and CA 14H respectively. The carbon range selected depends upon the final degree of hardness desired as well as other properties. Increasing carbon up to 0.25% increases hardness appreciably in the quenched, and quenched and drawn below 900° F. condition. Above 0.25% the increase in hardness is slight and these higher carbon contents, unless the slightly greater hardness is very essential as in wear applications, are not generally recommended, as ductility and shock resistance are seriously lowered.

In the quench hardened condition this alloy has its best corrosion resistance. Drawing the quench hardened material at 600° F. increases the ductility and shock resistance without decreasing the hardness to any appreciable extent, and without any effect on the corrosion resistance. It also is very effective in eliminating hardening stresses and the danger of cracking, and so is highly recommended.

The best hardness range for machinability is 220-240 BHN. This range is best obtained by tempering at 1200° F. for under 0.15% C, at 1300° F. for 0.15 to 0.25% C, and at 1400 F. for 0.25 to 0.35% C. Softening to too low a hardness causes gumming and poor machinability; also it causes low maximum hardness upon rehardening.

Molybdenum in amounts of 0.4 to 0.6% is sometimes added to improve machinability and high temperature creep resistance. Copper is often added to the extent of 1.0% to improve corrosion resistance and is occasionally combined with molybdenum additions. Nickel in amounts of over 0.75% and silicon over 1.0% are to be avoided. Nickel greatly increases the hardness in the tempering ranges used for machinability and necessitates lengthy special heat treatments. Silicon has a very detrimental effect on impact resistance when the alloy is drawn at 600° F.

Heat treatment for all carbon ranges of this alloy consists of oil quenching or air cooling from 1800° F. after slowly heating to temperature and holding for one hour, followed by tempering for 3 to 4 hours at the correct temperature necessary to obtain the desired properties. Tempering temperatures of from 900-1100° F. are to be avoided as this range produces low corrosion resistance and mechanical properties. Oil quenching from the hardening temperature produces slightly higher hardness values than air cooling, but is not practical for large castings. A hardening temperature of 1900° F. will produce slightly higher hardness values upon quenching in the 0.25 to 0.35% C grade.

Available on request

Copies of this article in convenient filing form, and a table of mechanical properties for conditions of heat treatment most commonly used, are available. Address requests to Publicity Dept., The Cooper Alloy Foundry Co., Hillside, N.J.

COOPER ALLOY
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VALVES · FITTINGS · CASTINGS

News Digest

Winners of the Annual Doehler Award for 1951 for die casting advancement are, left to right, Norman Dress of Precision Castings Co.; Charles A. Sanford, of Cleveland Hardware & Forging Co.; and Byron S. Van Horn, of Doehler-Jarvis Corp.

large plants, the "Safety Manual" is a working guide for the creating of correct working habits. The resulting reduction in human suffering will also result in the improved quality and increased production that comes from better labor relations.

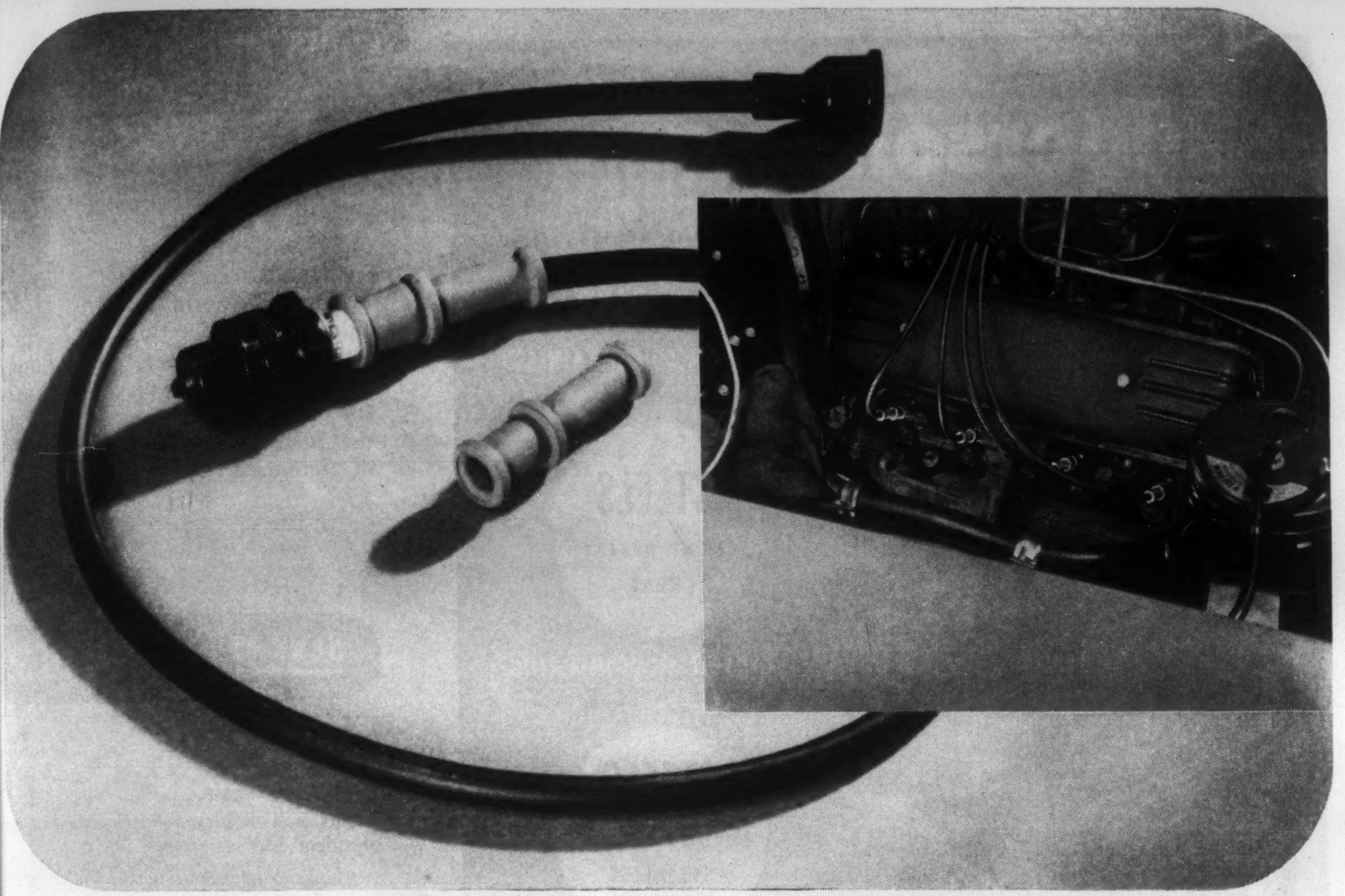
The Doehler Award, presented by A. T. Lillegran, president of the Institute during the annual meeting at the Edgewater Beach Hotel, included certificates and cash awards of $500 to each of three winners.

Bridgeport Brass Goes into Aluminum

Bridgeport Brass Co., one of the oldest and largest independent makers of brass, bronze and copper products, plans to broaden its line to include products made from aluminum.

The Company has been experimenting with this metal for several years. It explained the addition of another nonferrous metal as a raw material will be possible without any extensive alterations of its Bridgeport and Indianapolis plants. It plans to start on a gradual basis, making aluminum coils of accurate gage as well as seamless tube up to an outside diameter of 4 in. It also will extrude aluminum rods and shapes of commercial varieties.

Herman W. Steinkraus, president and chairman, in announcing the move said that during a recent trip



SILASTIC* boots plug ignition leaks!

It's no longer a trade-secret that some of the leading automobile manufacturers are using Silastic boots to plug ignition leaks. Molded of Silastic 250, these spark plug boots exclude moisture; remain flexible for an indefinitely long period of time at subzero temperatures and at operating temperatures in the range of 400° - 450°F. They withstand hot oil and they keep a spark at 27,000 to 40,000 volts from jumping over the outside of the plug.

These are the properties of Silastic that make engines easy to start even on a wet morning. And these are the properties that start engineers to work simplifying the design and increasing the service life of hot air shut-off valves, transmission systems, cooling fins on aircraft engines, anti-icing systems, traction motors, transformers and cable. You can do extraordinary things with Silastic, the Dow Corning silicone rubber that retains its properties over a temperature span of more than 600 degrees from —100° to +500°F.

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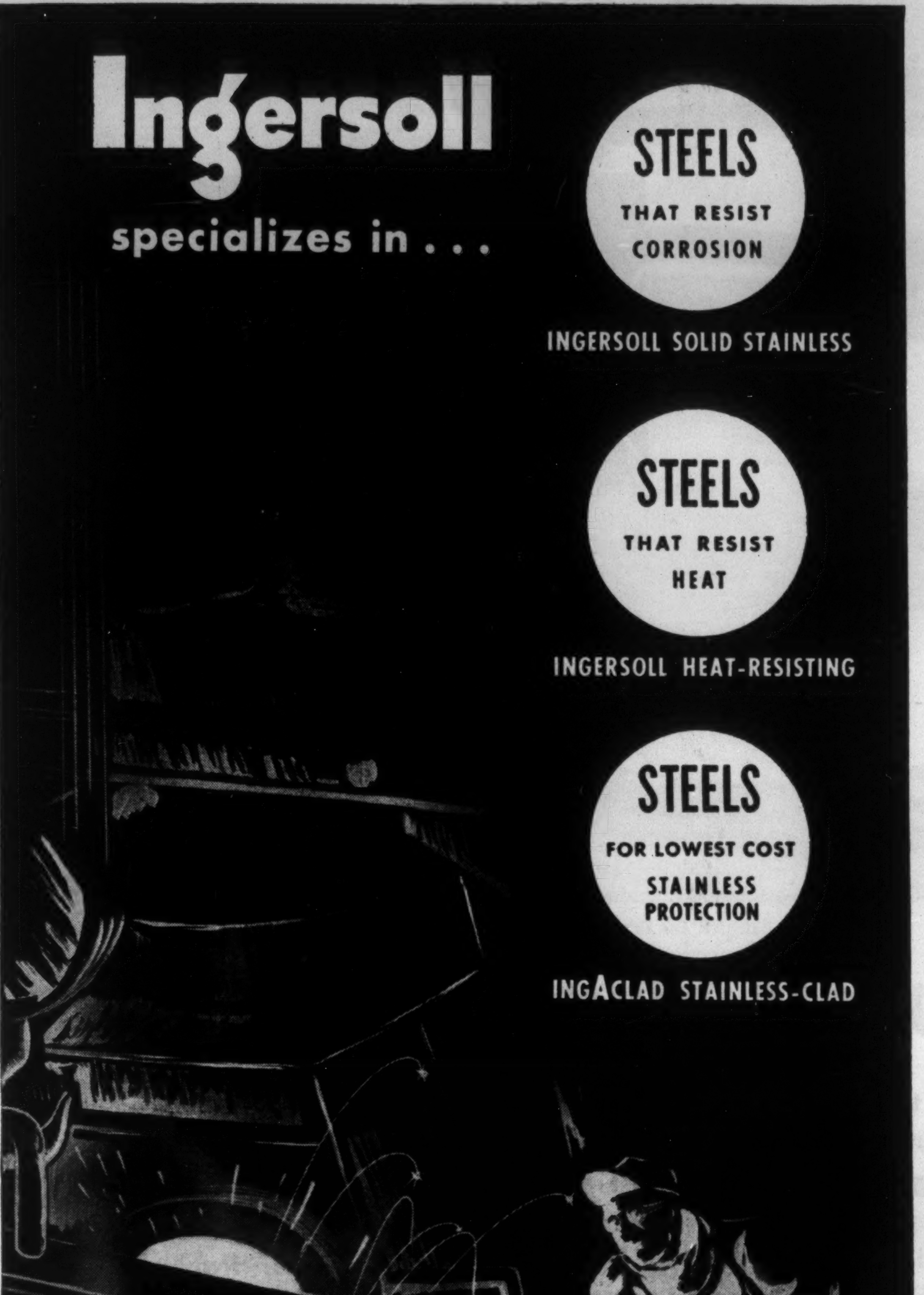

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News Digest

to Europe he had been greatly impressed by the number of European brass and copper mills which had successfully entered the aluminum business in World War II. He considers the present timely for similar action in this country. An additional influence is the present large demand for copper and zinc for defense and the increasingly greater availability of aluminum be added.

News of Engineers

Kaiser Aluminum & Chemical Corp. has announced the election of *Edgar F. Kaiser* as a member of the board of directors and *William P. B. Marks,* vice president and secretary.

Bjarne Klaussen has been named executive vice president of Hooker Electrochemical Co., and *Donald E. Springer* has been appointed chief engineer of the company.

Election of *Warden F. Wilson* as president and general manager of Donegal Manufacturing Corp. has been announced. Mr. Wilson was formerly general sales manager of Lebanon Steel Foundry, and is at present national chairman of the advertising and public relations committee of Steel Founders' Society of America.

Harold C. Weingartner has been elected vice president and general manager of the Equipment Div. of National Research Corp.

The election of five new officers and advancement of three other officers of Allis-Chalmers Manufacturing Co. has been announced by the Company's president. Four new vice presidents have been named: *W. G. Scholl,* general manager of the Tractor Div., was named vice president in charge of sales for the Division; *C. W. Schweers,* director of sales in the General Machinery Div., was elected vice president in charge of sales for the Division; *J. F. Roberts,* director of engineering in the General Machinery Div., was named vice president in charge of engineering for the Division; and *W. A. Yost,* manager of the Mechanical Power Dept., was elected vice president of the General Machinery Div. *G. F. Langenohl,* assistant treasurer, was elected to the position of treasurer and appointed assistant secretary.

Heading a list of executive promotions at Corning Glass Works, *John L. Ward,* general manager of the Electrical Products Div., has been appointed assistant comptroller of the Company. Succeeding Mr.

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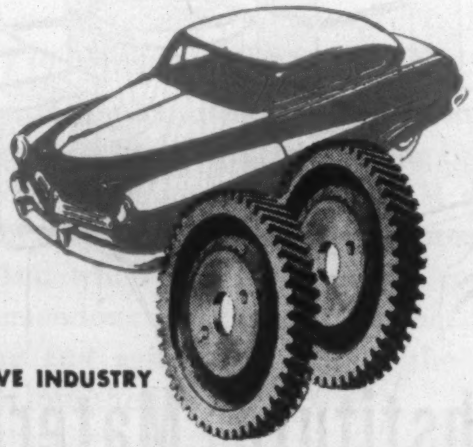

There are millions of automobiles using MICARTA timing gears on the road today. The gears can be fabricated to match the famous mass production of the auto industry. The versatility of MICARTA as a basic material creates a place for it in all industries. Explore its uses.

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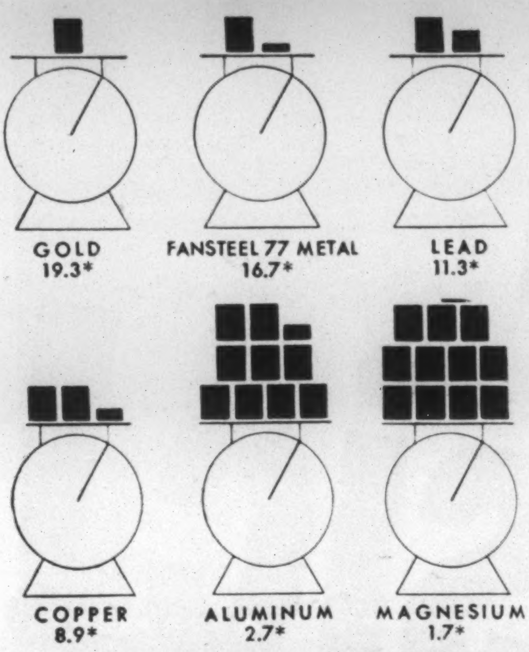

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Useful for rotors, flywheels, governors, balance weights where maximum weight is necessary in minimum space. Also useful for radiation shields against X-ray and gamma radiation.

Available forms include finished or semi-finished parts, bar, rod, rings, disks, slabs or special shapes. Fansteel Metallurgical Corporation, North Chicago, Illinois, U. S. A.

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SPECIAL PRODUCTS
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News Digest

Ward is *John L. Hanigan*, divisional manufacturing manager. Other promotions include *Norman J. Vang*, who was named manager of manufacturing for the Division; *Paul T. Clark*, who has been appointed to Mr. Vang's former position as manager of the Company's Pressware Plant; and *Julian H. Allen*, who succeeds Mr. Clark as manager of the Fall Brook Plant.

Appointment of *Harry W. Jobes* as general manager of United States Radiator Corp.'s Metal Products Div. plant in Chicago Heights has been announced by the Company.

The following appointments have been announced by The Dow Chemical Co. *Herbert A. Clouet* has been named maintenance superintendent, Madison Div.; *John M. Henske* has been elected assistant superintendent of the Magnesium Dept. rolling mill; and *J. P. Doan* has been appointed superintendent of extrusion operations, Magnesium Dept., Madison Div.

The Cro Plate Co., Inc. has announced the election of *Alan W. Brown* as president to succeed *Theodore L. Brantly, Jr.*, who met his death in an automobile accident. Simultaneously, the company announced the election of *Robert C. Allen*, previously treasurer, as executive vice president and treasurer.

Charles C. Buckland has been elected a vice president of Minneapolis-Honeywell Regulator Co. in a series of personnel changes recently announced by the Company's president. Mr. Buckland, who is also a director and secretary of the Company, will head a newly created sub-contracting division which will correlate and expand sub-contracting activities of the aeronautical and ordnance defense programs. *Glenn Seidel*, who has been assistant to the vice president in charge of engineering, has been appointed to the newly created post of director of ordnance. Another new post, superintendent of ordnance, will be filled by *Stanley J. Nelson*, superintendent of manufacturing. Other appointments include: *E. H. Salzman*, formerly assistant director of the Aeronautical Div., as director of aeronautical administration; *M. P. Fedders*, formerly works manager, to manager of aeronautical operations; and *Howard J. Stoops*, formerly manager of administration, to director of manufacturing.

The appointment of Dr. *James F. Eversole* as manager of research administration of Union Carbide and Carbon Corp. has been announced by the Company. Dr. Eversole will help coordinate the research activities of the Company's laboratories where basic research and development

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can assist you in evaluating the physical properties of the materials you are now using against those of potential value. The picturized records of such tests not only provide authoritative comparison, but also a guide to possible improvement.

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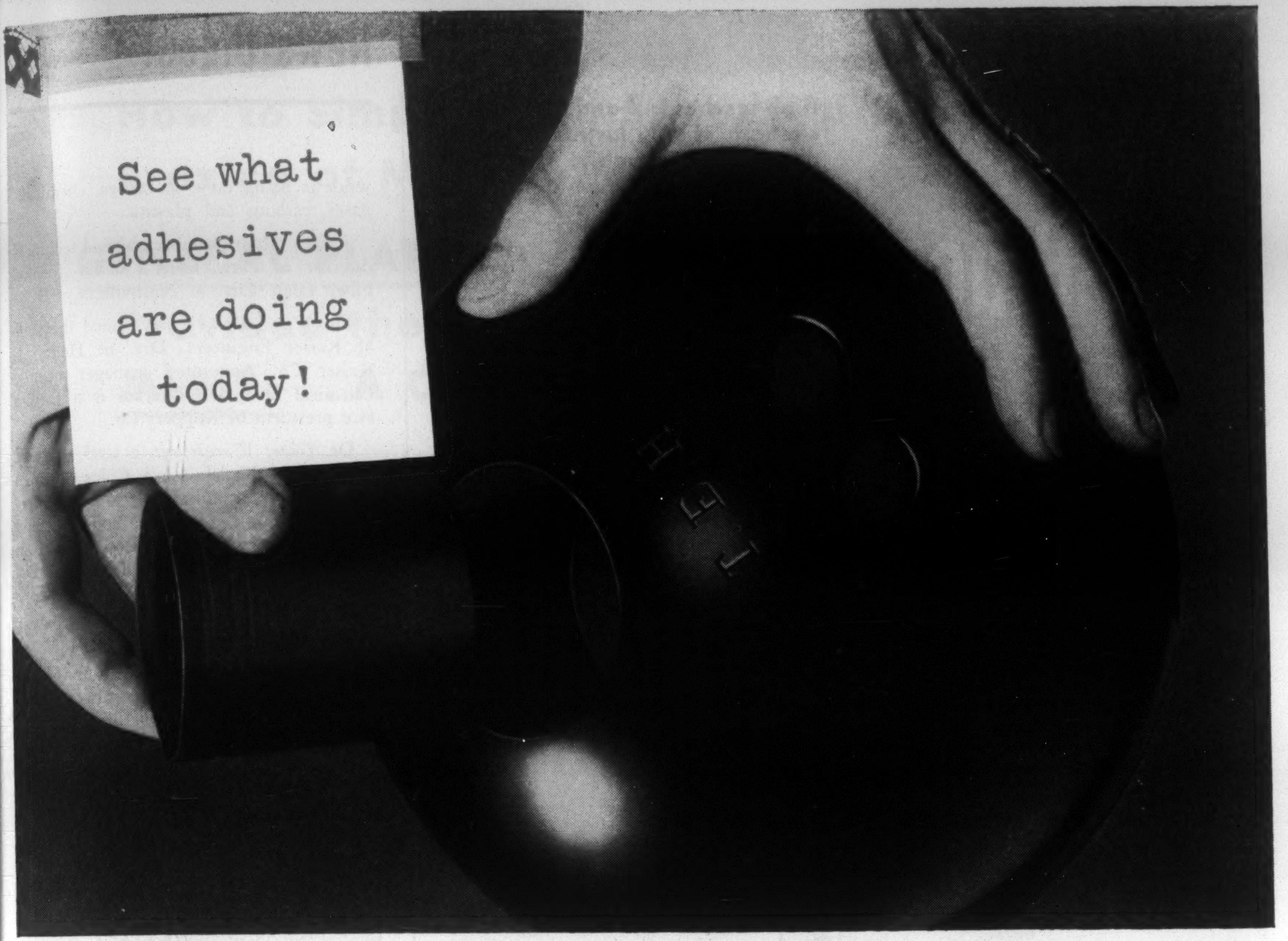
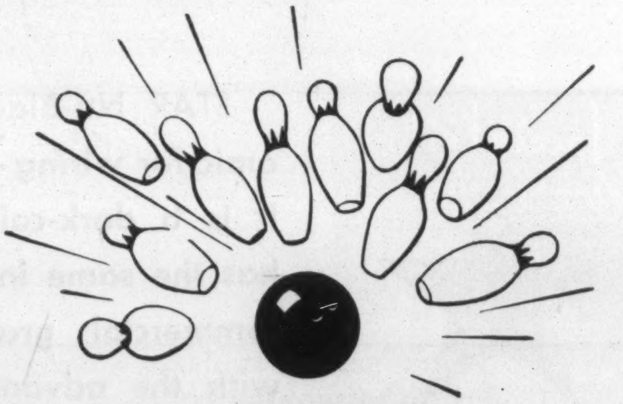


"Plugging" for more strikes



To bowlers, the "plug" is a familiar sight. When finger holes begin to wear, or must be changed to fit a certain grip, it is necessary to bore new holes in the ball—and plug the old ones. One prominent manufacturer had been installing plugs with pitch, a process that required a curing time of four or five days, and produced an imperfect bond. 3M developed an adhesive which not only gave a better bond, but speeded drying time by 400%. And when you consider the conditions the adhesive met—tremendous resistance to impact, temperature changes, shrinking and aging—you realize the extensive engineering that goes into the product.

It is this same ability to engineer each compound to a specific use that makes *all* 3M adhesives, coatings and sealers *tops in performance!*

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Call the 3M office in your city and investigate, with the help of a laboratory-trained field engineer, the potential that adhesives hold for you. And for more information and a valuable 32-page booklet, write 3M, Dept. 611, in Detroit.

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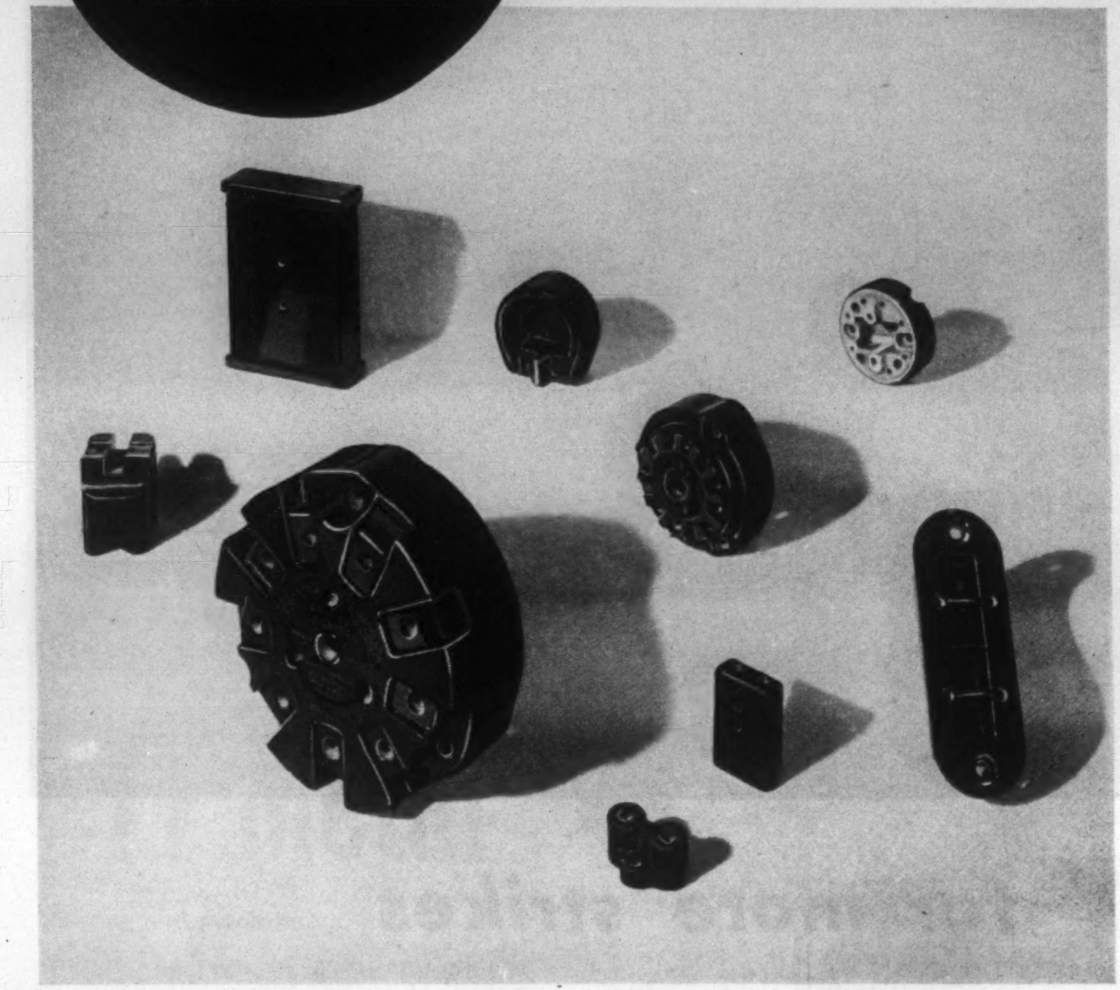

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News Digest

work is being done on alloys, chemicals, gases, carbons and plastics.

I. Dow Moore has been named technical director of Ferro Corp.'s newly formed Fiber Glass Div. at Nashville.

Dr. *W. C. Rueckel* has joined the staff of Kaiser Engineers, Div. of Henry J. Kaiser Co. Appointed manager of the Chemical Div., Dr. Rueckel is a former vice president of Koppers Co.

Dr. *Grant Wernimont,* a staff assistant in Eastman Kodak Co.'s Color Control Div., has been appointed to the International Union of Pure and Applied Chemistry's newly formed Commission on the Expression of Analytical Results. Dr. Wernimont is well known for his work on use of statistical methods in quality control.

L. K. Stringham has been appointed chief engineer for the Lincoln Electric Co. Formerly director of welding development, Mr. Stringham is a member of the NEMA Navy Committee for the development of low hydrogen electrodes, a member of AWS-ASTM Committee for Filler Metal, a fellow in the American Institute of Electrical Engineers, and a member of the American Welding Society.

In acting upon *E. L. Parker's* resignation as president, the board of directors of Columbia Steel & Shafting Co. elected him as chairman of the board, and *George E. Parker* as president and chief executive officer of the Company.

Alex L. Gresham has been appointed division metallurgist for standard practices in the Metallurgical Dept. of the American Steel & Wire Co., according to a recent Company announcement.

A. B. Fisher, Jr., chief engineer for the Engineering and Construction Div. of Koppers Co., Inc., has been named operating manager of Koppers Freyn Engineering Dept., to succeed *Gordon Fox,* who is retiring. Other appointments announced by the Company include: *R. J. Sprott* to succeed Mr. Fisher; *C. S. Carden* to replace Mr. Sprott as assistant chief engineer; and *A. D. Orefice* to succeed Mr. Carden as manager of the Division's byproduct section.

F. S. Washburn, member of the board of American Cyanamid Co. and director of its Agricultural Chemicals Div., has been elected president of the firm's Canadian subsidiary, North American Cyanamid Ltd. Mr. Washburn succeeds *H. P. Eastman,* who is retiring from the post.

Horizons Inc. has announced the following appointments: Dr. *John T. Burwell, Jr.* as assistant to the director of research; *F. Clifton Wagner,* as project supervisor in the Metallurgy Dept.; *Herbert Packer,* as a member of the Metallurgy Dept.; *Cecilia M. Torda,* as a member of the Ceramics Dept.; *Rita R. Carpenter,* as a research staff member; and

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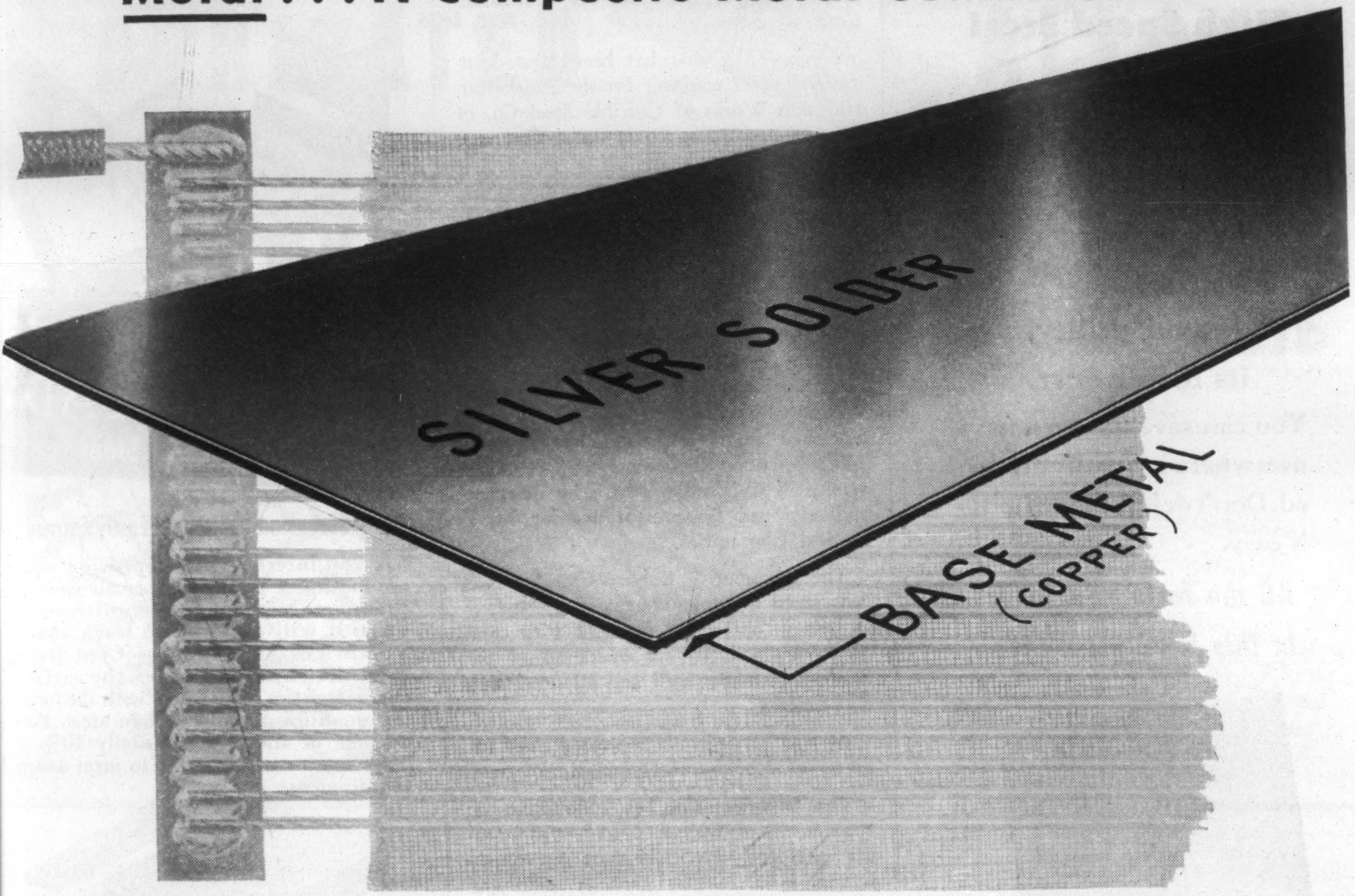
Provided the Solution with a "Solder-Flushed" Metal . . . A Composite Metal Combination



Recently a manufacturer had the problem of soldering leads from a screen to a copper strip. The old method required cleaning and positioning separate pieces of solder on each spot and then heat. This method was time consuming and costly.

General Plate Engineers solved the problem with "Solder-Flushed Copper Strip." Now the operation involves laying the leads on the strip and heating each wire. The result—a strong soldered joint at considerable savings in time.

General Plate "Solder-Flushed" metals make contact brazing quicker and easier. They eliminate handling of separate pieces of solder foil, provide a better, stronger joint. They can be supplied with solder to base or precious metal, copper layer for copper brazing or low silver content solder clad to base metal.

No matter what your metal problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals, or base to base metals can overcome your problems...often reduce costs.

General Plate Products include . . . Precious metals clad to base metals, Base metals clad to base metals, Silver solders, Composite contacts, buttons and rivets, Truflex® Thermostat metals, Platinum fabrication and refining, Age-hardenable, #720 Manganese Alloy. Write for information.

Have You a Composite Metal Problem?
General Plate can solve it for you

GENERAL PLATE
Division of Metals & Controls Corporation
611 FOREST STREET, ATTLEBORO, MASS.

As sure as the coming of Spring

. . . you will switch to MOLYBDENUM High Speed Steel

The increased usage of Molybdenum high speed steel is based on:

its merits,

its easy availability,

its lower cost.

You can save tungsten for uses where it is really needed. Don't delay, the switch is easy.

All the facts you need in this FREE BOOKLET.

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News Digest

Martin Arthur Levitin, Samuel J. Strindberg, Peter F. Mataich and *Robert E. Burket* as members of the research staff.

C. Richard Newpher has been named executive vice president in charge of operating functions of Laminated Plastics, Inc.

T. W. Merrill has been appointed chief metallurical engineer of the Vanadium Corp. of America.

George I. Ziders has been elected industrial plant engineer for the Sanderson-Halcomb Works of Crucible Steel Co. of America, according to a recent Company statement.

The Dynakon Corp. has announced the appointments of *Burton Field* as plant manager and *William Schwartz* as chief chemist.

William W. Wellborn has been appointed research engineer of the Carbide Research & Development Dept. of the Firth Sterling Steel & Carbide Corp. Mr. Wellborn has been associated, for the past five years, with the Los Alamos, AEC, Scientific Laboratories of the University of California, where he designed and equipped the present powder metallurgical laboratories.

The Automotive Rubber Co., Inc. has announced the appointment of *R. A. Lees* as new general plant manager with complete rseponsibility for operation of the firm's new rubber mill and all processing departments.

George Breza has been named chief engineer of Mackintosh-Hemphill Co.

The Wel-Met Co. has announced the appoinment of *Don S. Urquhart* as product engineer. Mr. Urquhart previously served in a similar capacity with the U. S. Graphite Co.

Ira G. Needles, vice president of the B. F. Goodrich Rubber Co. of Canada Ltd., has been elected Company president to succeed *George W. Sawin,* who is resigning.

James W. Liddell has been named manager of high-temperature insulation products of the Armstrong Cork Co. *Warden N. Hartman* has been appointed manager of the Industrial Insulation Dept.

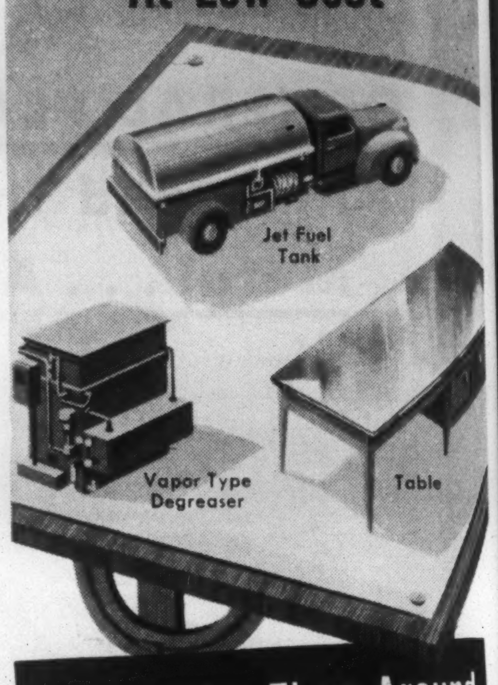
Louis S. Gleason has been named superintendent at the General Electric Chemical Dept.'s plastics molding plant, according to a recent Company release.

The Industrial Chemicals Div. of the American Cyanamid Co. has announced the appointment of Dr. *A. J. Weith* as product supervisor in the Synthetic Organic Chemicals Dept.

Charles L. Kepley has been appointed chemical field engineer for A & P Finishing and Manufacturing Co. Mr. Kepley will assist *Dan Finlay,* chief field engineer.

Joseph W. Gray has been appointed

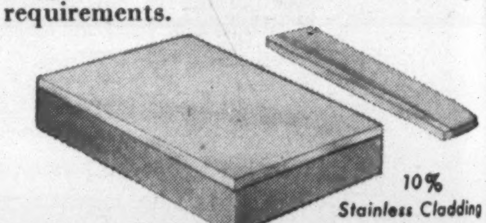
It's A Cinch To Improve Products At Low Cost



By Designing Them Around PERMACLAD Stainless Clad Steel

Truly Corrosion Resistant! Easily Formed!

Are you interested in improving your product, and giving it corrosion resistance where corrosion resistance is needed? Then it will pay you to learn about PERMACLAD Stainless Clad Steel. PERMACLAD combines the surface characteristics of stainless with the forming qualities of mild carbon steel. Percentage of stainless is usually 10% or 20% but it can be varied to meet design requirements.



You can conserve materials in critically short supply by using PERMACLAD. Best of all you can vastly improve your products at low cost. Executives, Designers, Engineers and Architects everywhere are specifying PERMACLAD. Get more information about this modern material now. Write for booklet D-97.

Improve Design at Low Cost by Specifying PERMACLAD

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STAINLESS CLAD STEEL
ALAN WOOD STEEL COMPANY
CONSHOHOCKEN, PA.
125 Years of Iron and Steel Making Experience
125th A.W. YEAR

Other Products: A. W. ALGRIP Abrasive Floor Plate • A. W. SUPER-DIAMOND Floor Plate • Plates • Sheets • Strip • (Alloy and Special Grades)

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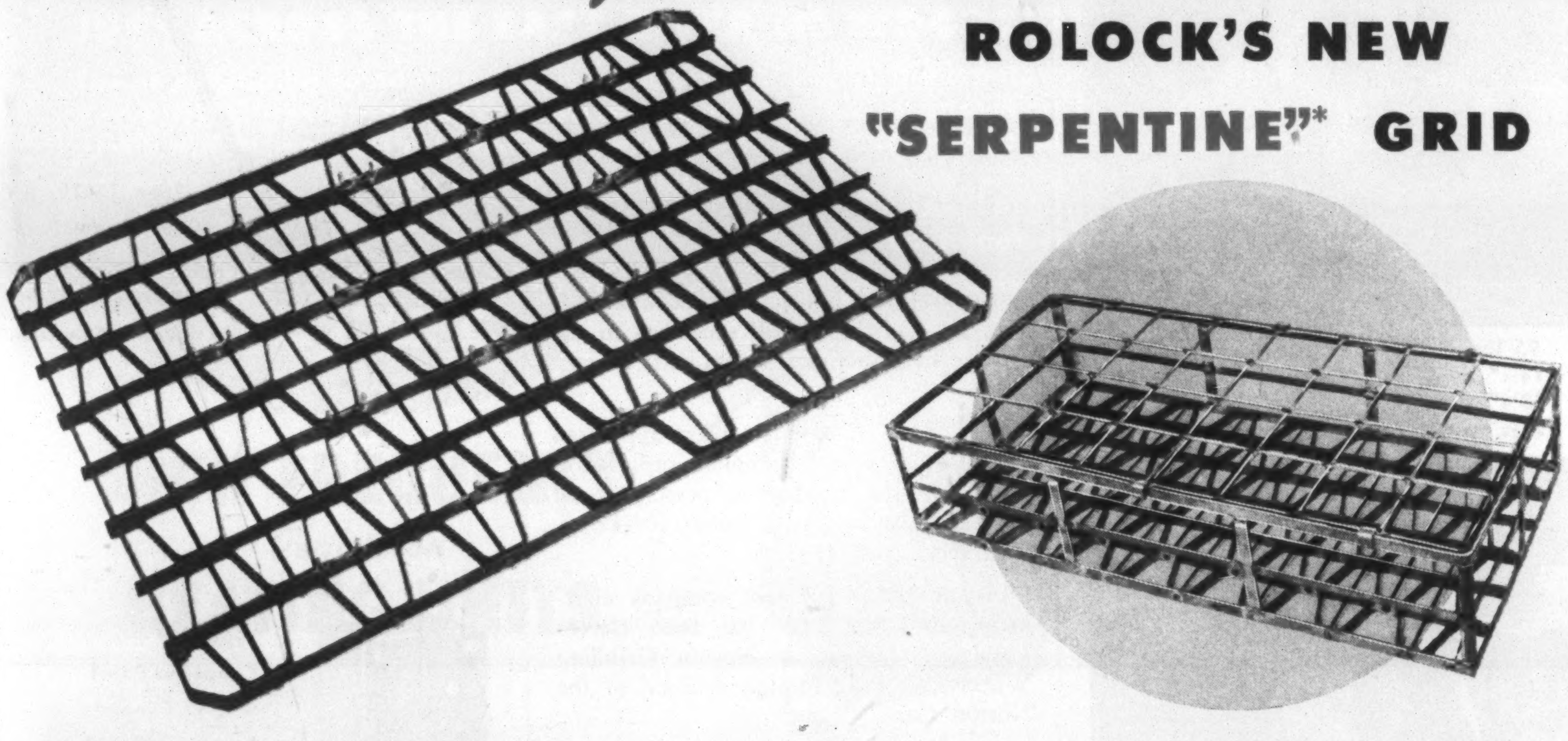
HEAT AND CORROSION RESISTANT

FABRICATED ALLOYS

Introducing . . .

ROLOCK'S NEW "SERPENTINE"* GRID



Rolock engineers have designed this distinctly different "Serpentine" alloy grid to meet the rigid requirements of modern heat treating practices. It is very light in weight, yet capable of performing with minimum distortion for an extremely long service life . . . *never previously attained.*

Simple in design and fully articulated with loose tie rods, the grid is constructed with longitudinal bars as principal load carrying members, spaced with serpentine-like intermediate bars which serve to maintain vertical alignment.

Versatility of application is shown above. Inconel tray with positioning lugs used for copper brazing taurus assemblies at 2050°F. Basket, also of Inconel, used for annealing, quenching and acid pickling steel components in a continuous cycle. Full details on application.

*Patent applied for

Offices: PHILADELPHIA, CLEVELAND, DETROIT, HOUSTON, INDIANAPOLIS, CHICAGO, ST. LOUIS, LOS ANGELES, MINNEAPOLIS, PITTSBURGH

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Easier Operation, Lower Cost

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MEANS
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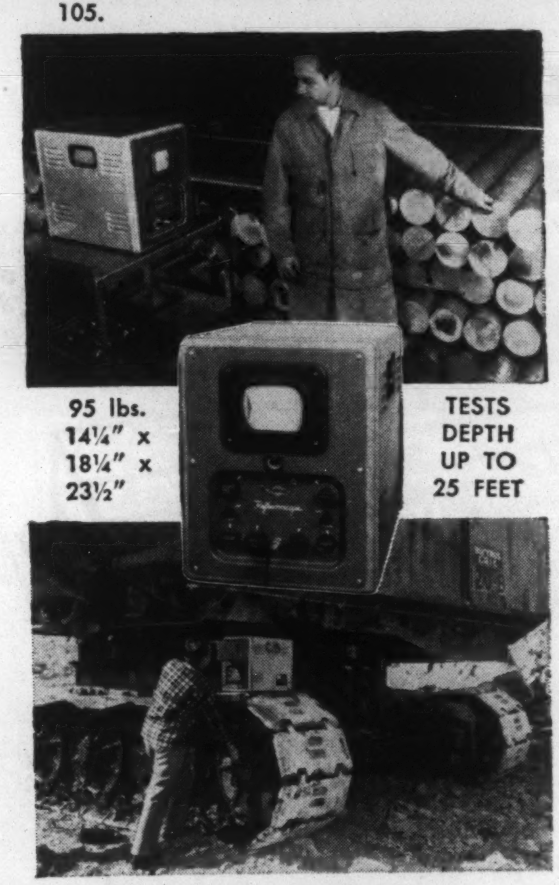
Ultrasonic
INSPECTION OF METALS
AT LOW COST
IT'S Portable, TOO

Reflectoscope non-destructive testing locates internal defects accurately—instantaneously. Penetrates up to 25 feet. Tests raw stock, semi-finished and finished products and detects fatigue fractures. Available for rent, for lease and for sale. Write for descriptive bulletin 50-105.



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News Digest

division metallurgist for wire at the Joliet Works of the American Steel & Wire Co.

Lindberg Steel Treating Co. has made the following new appointments at its Chicago plant: *E. J. Pavesic,* director of research; *N. O. Kates,* works metallurgist; and *F. J. Minch,* metallurgist.

Leo Martin has joined the staff of Flexible Tubing Corp. as machine design engineer in charge of the Company's machine development and design laboratory; *James W. Hull* has joined the company as chief of the Chemical Laboratory and Development Section.

C. W. Miller has been named manager of large power transformer engineering for the Transformer Div. of the Westinghouse Electric Corp.

Continental Can Co.'s board of directors has elected *Lawrence Wilkinson* and *E. R. Van Meter* as new vice presidents.

Wilbur E. Lunger has been elected a vice president of the American Car and Foundry Co.

Dennis Ord has joined Sam Tour & Co., Inc., where he will specialize in the chemical analysis of titanium and titanium alloys.

Gerald G. Foster has been appointed plant manager with complete supervision of engineering, production, personnel and packaging as his major duties for Powr-Pak, Inc.

According to a recent company statement, *John C. Ewer* has been elected managing director of Norton Grinding Wheel Co., Ltd., foreign division of the Norton Co.

Dr. *Charles H. Moore,* inventor and developer of Rutile gems, often referred to as Titania, has been appointed head of the Metal and Ceramic Div. of P. R. Mallory & Co., Inc.

The appointment of Dr. *G. R. Fitterer* as dean of the Schools of Engineering and Mines at the University of Pittsburgh has been announced.

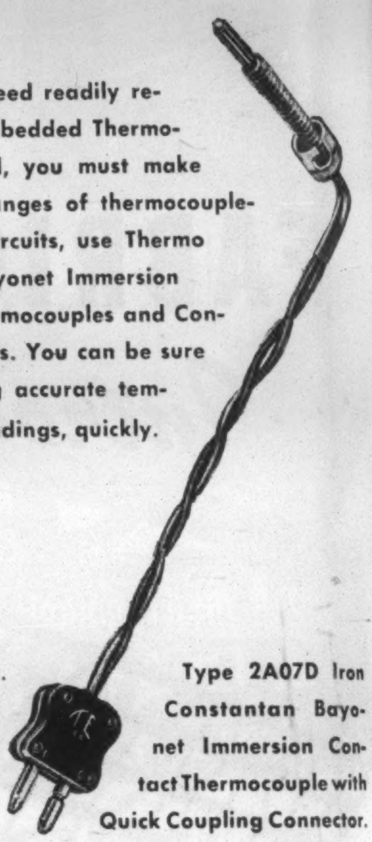
Otto Zmeskal, director of the Dept. of Metallurgical Engineering at Illinois Institute of Technology, was a participant in the presentation of a citation and medal to President Truman. The presentation was made on behalf of the American Society of Metals in recognition of the President's part in making the World Metallurgical Congress possible.

Professor *Gregory Jamieson Comstock,* director of the Powder Metallurgy Laboratory at Stevens Institute of Technology, was awarded the Certificate of Appreciation from the Department of the Army for services with the Technical Industrial Intelligence Committee, Joint Chiefs of Staff, World War II.

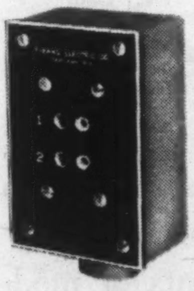
Kingsley W. Given, professor of speech,

THEY'RE A TEAM

When you need readily removable, embedded Thermocouples; and, you must make frequent changes of thermocouple-pyrometer circuits, use Thermo Electric's Bayonet Immersion Contact Thermocouples and Connector Panels. You can be sure of obtaining accurate temperature readings, quickly.



Type 2A07D Iron Constantan Bayonet Immersion Contact Thermocouple with Quick Coupling Connector.



Type JBW Connector Panel with FS Conduit Box for 1, 2, 3, 4 or 5 thermocouple circuits.

For complete descriptions of our many types of Thermocouples, Quick Coupling Connectors, Panels, Lead Wires and Accessories, Write for Catalog

FAIR LAWN Thermo Electric CO., INC. NEW JERSEY

ANOTHER CHAPTER IN THE HISTORY OF LEPEL

Lepel's NEW HOME

JUST ACROSS THE EAST RIVER IN WOODSIDE, NEW YORK CITY

The new building containing our new factory and offices, designed on the most modern architectural lines, reflects the steady gains made by Lepel for a quarter of a century.

The reputation enjoyed by Lepel in the field of Induction Heating equipment has been made possible by the high quality of the Lepel products and the integrity of the Lepel organization with its pleasant customer relationship.

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HIGH FREQUENCY *Induction* HEATING UNITS

SPARK GAP CONVERTERS
from 4 kw to 30 kw

ELECTRONIC TUBE GENERATORS
from 5 kw to 50 kw

LOW COST 2 KW PORTABLE UNITS
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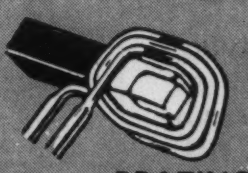
Heat localized exactly where wanted, to any desired temperature up to 5000° F.



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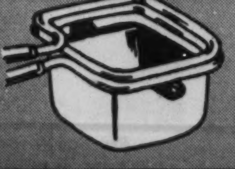
Readily melts metals and alloys of high melting point.



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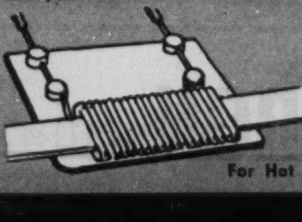
Neater, faster, without waste or discoloration.



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PELRON KLEENWELD *Anti-Spatter* COMPOUND

prevents weld spatter sticking to metals.

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- **Water soluble, for easy application**
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- **Does not interfere with painting.**
- **Non-inflammable, non-toxic.**
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News Digest

Kansas State College, now on leave, has been appointed executive assistant for the World Metallurgical Congress to William H. Eisenman, secretary of the American Society for Metals.

News of Companies

Kopp Glass, Inc. has announced the opening of its new office at East Orange, N. J., which replaces its headquarters in New York City.

Plans for additions to plant and equipment of *The American Welding & Manufacturing Co.* to cost in excess of $5,000,000 have been announced by the Company.

Lincoln Electric Co. has moved into its new plant at 22801 St. Clair Ave., Cleveland 17.

American Cyanamid Co. has announced the consolidation of its several office and warehouse locations in Los Angeles into one newly constructed building at 2300 S. Eastern Ave. Open house ceremonies marked the formal opening.

Construction work on the new *Aluminum Co. of America's* aluminum smelting plant at Rockdale, Tex., has begun, according to a recent Company announcement. It is expected that the plant will be in partial operation late in 1952.

An expansion of *Pittsburgh Plate Glass Co.'s* power-driven brush facilities has been started. The new plant will be a single story structure, which when completed, will be equipped with new and improved machinery, and engineering, research and product development staffs expanded.

The Hendrick Manufacturing Co. recently celebrated its 75th anniversary.

The Aro Equipment Corp. has purchased *Pyles Industries, Inc.*, Detroit. This new corporation will bear the name of *Pyles Industries, Inc.*, subsidiary of Aro Equipment Corp.

Federated Metals Div., American Smelting and Refining Co., has announced the purchase of *Frictionless Metal Co.*

Purchase of a factory building has been announced by *Clearing Machine Corp.* The new plant will be utilized immediately in expanding the production of the Company to meet defense requirements.

The formal opening of *General Motors Corp.'s* three engineering staff buildings at the General Motors Technical Center was held recently. The new technical

PHOENIXSPUN *Processing*

Meets Exacting AIR-FORCE Specifications . . . . .

If your products require the close tolerances demanded by leading producers of aircraft engines, parts, and assemblies to meet defense specifications — play safe and rely upon PHOENIXSPUN Processing . . . Spinning, Deep Drawing, Fabricating.

Stainless Steel and Aluminum Parts for Gas Turbine Aircraft Engines.

Prompt Response To Your Inquiries.

Metal Spinning Division PHOENIX PRODUCTS CO.
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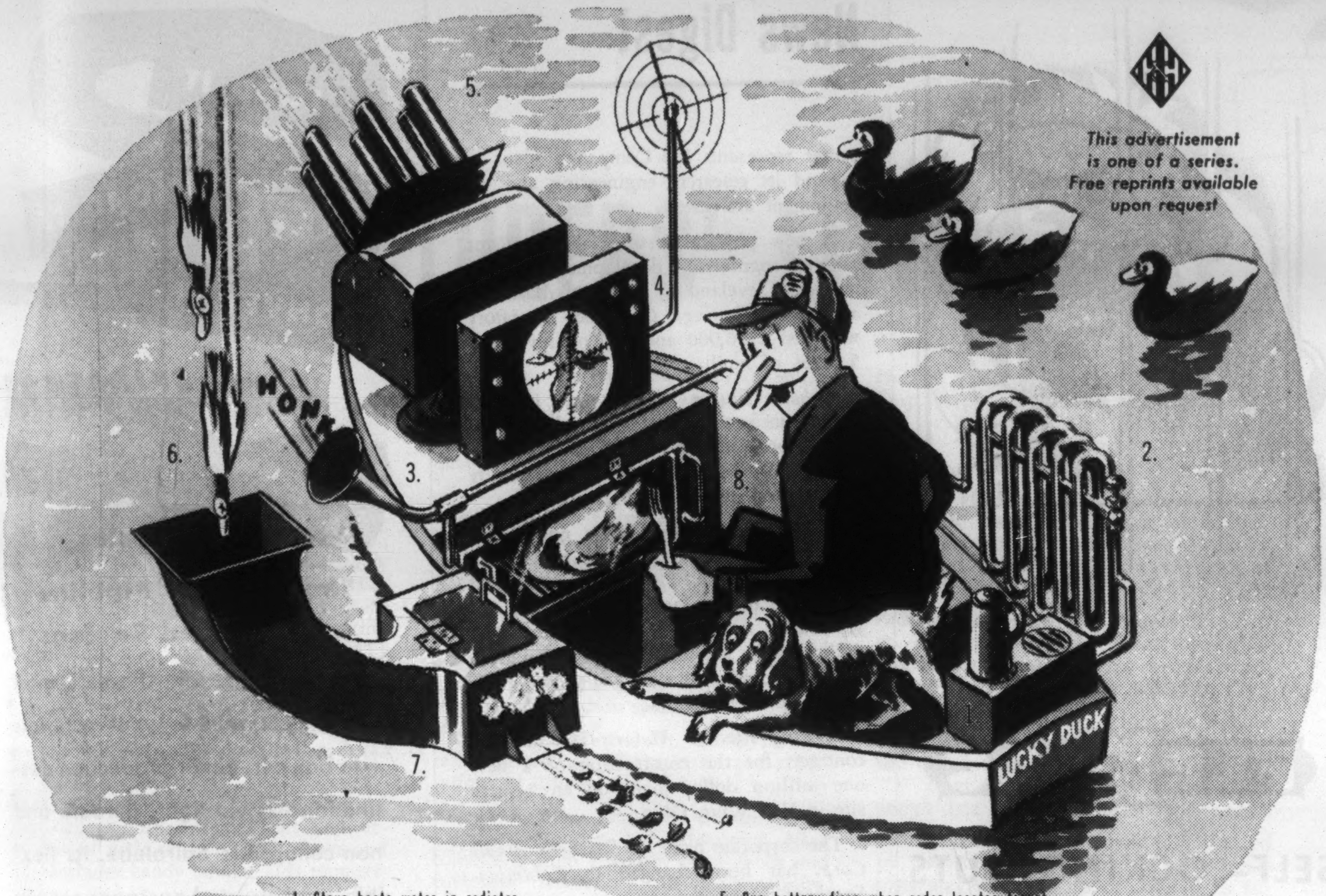
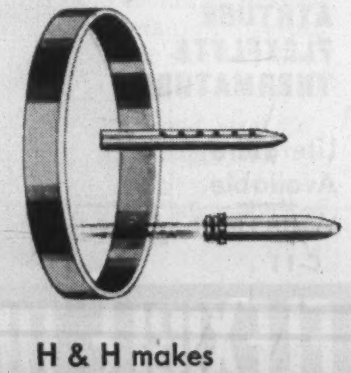


1. Stove heats water in radiator.
2. Radiator provides indoor comforts for "Outdoor Man."
3. Escaping steam sounds duck call.
4. Radar screen shows position of ducks.
5. Gun battery fires when radar locates target.
6. Game falls into duck chute.
7. Chute carries duck into de-feathering machine.
8. Hot roast duck!

There once was a hunter named Trucks
Who ordered parts for this gunboat deluxe;
Not ducking the issue at all,
We said, "Sir, we're delighted
But please don't feel slighted
If top-rated jobs get first call."

There is a difference between the tubular parts one would need for a hunting boat like this, and the primer tubes, rotating bands and other defense items which H & H makes. While we supply both, for the present top-rated jobs must come first. The skill which has made us famous for the precision manufacture of especially hard-to-fabricate tubular parts, is now being used to meet strict Army-Navy specifications, also essential civilian requirements. And so, no matter what your needs, always remember that H & H is one of the country's leading sources for brass and copper tubing, also fabricated parts. Why not call us about your defense requirements, today?



H & H makes brass or copper tubing ranging from 1/8" O.D. to and including 1½" O.D. Also brass and copper LOCKSEAM tubing for aircraft, jeep, truck and stationary engine cooling components.

H&H TUBE AND MANUFACTURING COMPANY
252 North Forman Avenue, Detroit 17, Michigan
Originators and sole makers of "Metalflo"— the economy tubing

H & H MEANS QUALITY AND SERVICE IN BRASS AND COPPER TUBING

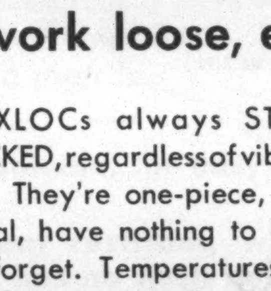
FLEXLOC ®

SELF-LOCKING NUTS

can't work loose, either

FLEXLOCs always STAY LOCKED, regardless of vibration. They're one-piece, all-metal, have nothing to lose or forget. Temperatures to 550° F. don't bother them, and you can use them again and again with no appreciable loss of torque.

Write for latest bulletin and free samples.



FLEXLOC Self-Locking Nut, "regular" type.

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STANDARD PRESSED STEEL CO.

JENKINTOWN 58, PENNSYLVANIA

News Digest

center represents the Company's plans to expand its research, engineering and development activities.

A new physical testing laboratory for railway engineering development will be built in Cleveland by *National Malleable and Steel Castings Co.* The laboratory will cost $750,000 and will occupy about 5 acres of land.

Auburn Button Works, Inc. has expanded its production facilities by installing compounding and additional extruding equipment and a laboratory for quality control and plastic formulating.

Electro Metallurgical Co.'s new ferro-alloy plant at Marietta, Ohio has started partial production. The new plant is said to be one of the largest of its type, and represents a major share of the 135 million dollar expansion program launched by the Company to meet the growing demands for ferro-alloys.

Sterling Electric Motors, Inc. has let contracts for the construction of a new one million dollar plant on an 11-acre site in Van Wert, Ohio.

The corporate name of *Southern Alkali Corp.* has been changed to *Columbia-Southern Chemical Corp.*

News of Societies

Engineering honors and cash awards totaling $5,000 have been given by the *Lincoln Arc Welding Foundation* of Cleveland to 63 young engineers in 28 states. Funds totaling $1750 were also awarded to three engineering schools to establish scholarships in honor of and named for the engineers receiving the main awards.

Battelle International, the new international research institute to be established in Europe, will maintain laboratories and offices in several Western European countries. It will, in addition, place research investigations in existing research institutes of Europe and in European universities and technical schools.

The Copper and Brass Research Association received the American Trade Association Executives Grand Award at the ATAE annual meeting.

The *Instrument Society of America* at its Sixth Annual Instrument Conference and Exhibit elected the following national officers: Dr. Arnold O. Beckman, president; David M. Boyd, Jr., vice president; Robert T. Sheen, vice president.

(*More News on page 176*)

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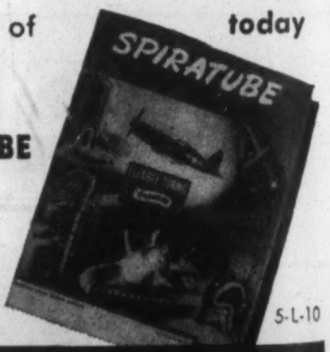

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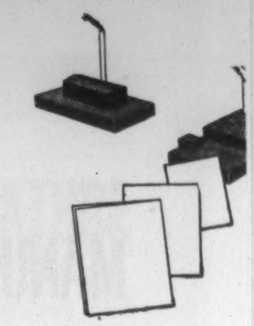

MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Tool Steels. Allegheny Ludlum Steel Corp., 197 pp, ill, No. TS25-Ed 1. Detailed data includes properties, applications and types of tool steels, selection of proper steel, available tool steel products, and working of tool steels. (1)

Thin Stainless Strip Steel. Armco Steel Corp., 4 pp, ill. Description, properties, uses and advantages of this firm's thin-gage stainless steel strip, 0.01 to 0.001 in thick. (2)

Steel Sheets and Wire. Continental Steel Corp., 20 pp, ill. Specifications and description of wide range of steel sheets and wire. Includes handy tabular aids to specification. (3)

Stainless Steel Specifications. Peter A. Frasse & Co., Inc., chart, Sec. A, No. 2. Government specifications chart for stainless steels, including Military, Aeronautical, Navy, Army and Federal Specifications. (4)

Nickel Alloyed Cast Irons. The International Nickel Co., Inc., 36 pp, ill. Engineering properties and applications of eight types of Ni-Resist austenitic nickel alloy cast irons. (5)

Machinable Steels. Jones & Laughlin Steel Corp. Properties and grades of J & L "E" Steel, said to have high machinability, give better finishes, and extend tool life. (6)

Galvanized Steel. Sharon Steel Corp. Brochure summarizes test data on Galvanite zinc coated steel said to fabricate like ordinary cold rolled steel, resist corrosion for years. (7)

Graphite Steel. The Timken Roller Bearing Co., Steel & Tube Div. Data on properties and applications of graphitic steels in Timken Graphitic Steel Data Book. (8)

Stainless Clad Steel. Alan Wood Steel Co., No. D-97. Properties, advantages and applications of Permaclad, stainless clad mild carbon steel said to combine advantages of both. (8A)

Nonferrous Metals

Lead-Base Babbitt. The American Crucible Products Co. Data sheets on properties and applications of Promet XXX, lead-base babbitt said to have qualities superior to tin base babbitts. (9)

Bronze Corrosion Resisting Alloys. Ampco Metal Co., 16 pp, ill, No. PI-2. Properties, corrosion resistance, available forms and applications of Ampco nonferrous alloys for process industries. (10)

Copper-Base Casting Alloys. Barth Smelting Corp., 40 pp, ill. Detailed Federal, Navy, ASTM, SAE and AMS specifications for nonferrous ingots and castings plus data on purchase and use of ingot metals. (11)

Magnesium. The Dow Chemical Co., 8 pp, ill, Vol. 2, No. 4. *Magnesium Topics* discusses up-to-date devolopments in processing and utilization of magnesium. (12)

Dense, Machinable Metal. Fansteel Metallurgical Corp. Description, properties and applications of Fansteel 77 Metal, dense metal said to be useful for rotors, flywheels and radiation shields. (13)

Lithium. Foote Mineral Co., 24 pp, ill. Detailed description of properties and applications of lithium and its salts. (14)

Aluminum Alloy. Frontier Bronze Corp. Data on Frontier 40-E aluminum alloy combining high strength, good shock and corrosion resistance and machinability. (15)

Laminated Metals. General Plate Div., Metals and Controls Corp., 4 pp, ill, No. 1a. Properties and uses of various laminated metals, including precious metal overlays and laminated silver contacts. (16)

Welding Nickel Alloy. Illium Corp., 4 pp, No. 105B. Instructions for metallic arc and oxyacetylene gas welding of Illium, nickel-base, corrosion resistant alloy. (17)

Powdered Metals. The New Jersey Zinc Co., 4 pp, ill, Vol. 3, No. 1. *Metal Powder Press* shows numerous ways in which metal powders are being used to cut fabrication costs of metal parts. (18)

Contact Materials. Stackpole Carbon Co., No. 12. Shows company's contact types of such materials as silver graphite, silver, molybdenum, and copper graphite. Includes data on materials and their applications. (19)

Nonmetallic Materials • Parts

Felt Vibration Mounts. American Felt Co., 16 pp, ill. Description, uses, selection data and costs of Vibra-Mount felt mounts, said to cut transmitted vibration 85%. (20)

Molded Plastics, Hard Rubber. American Hard Rubber Co., 80 pp, ill. Handbook of properties, tolerances and weights; design techniques, machining and finishing methods for this firm's hard rubbers and plastics. (21)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 173.

Plastics Fabrication. The Amplex Mfg. Corp., 4 pp, ill. Shows facilities for heating, deep drawing and free blowing of acrylic plastics. Describes precautions taken to insure accuracy. (22)

Extruded Plastics. Anchor Plastics Co., Inc., 8 pp, ill. Latest applications of custom-made thermoplastic extrusions. Includes properties of thermoplastics and types of extrusions available. (23)

Packaging Materials. The Angier Corp., 16 pp, ill. Describes facilities for solving industrial packaging problems and this firm's various types of wrapping materials. (24)

Rubber Ring Seals. The Arrowhead Rubber Co., 8 pp, ill, No. 502 B. Specifications and descriptions of this company's rubber "O" rings. Gives properties of rings and design data for proper installation. (25)

Industrial Insulation. Baldwin-Hill Co., 26 pp, ill, No. J-1R. Thermal properties, costs and specifications of insulations for heat treating equipment, ovens and refrigerating units. (26)

Investment Castings. Casting Engineers, Inc., 4 pp, ill, No. 17. Discusses advantages of investment castings and characteristics of investment cast parts custom-made by this firm. (27)

Porcelain Products. The Colonial Insulator Co., 12 pp, ill. Shows wide range of custom-made porcelain products, including insulators, forms for dipped rubber goods, and kitchen appliances. (28)

Coated Fabrics. The Connecticut Hard Rubber Co. Uses, chemical, electrical and mechanical properties, and availability of heat resistant silicone rubber coated glass fabrics. (29)

Plastic Insulation. Continental Coatings Corp., 8 pp, ill. Advantages, properties and applications of Hylag plastic insulation for cutting heat losses. Easily applied by trowel or spray. (30)

Plywood. Douglas Fir Plywood Assn., 32 pp, ill. Series of articles shows how to use plywood effectively in fixtures, displays, posters and signs. (31)

Glass Products. Dunbar Glass Corp., 4 pp, ill. Descriptions of this firm's various industrial glasses. Explains advantages of glass to the designer and gives physical properties. (32)

Plastic Developments. E. I. du Pont de Nemours & Co. (Inc.), 4 pp, ill, No. 49. *Plastics Bulletin* shows new applications of this company's plastics, including nylon, Teflon and Alathon. (33)

Plastics Parts. The Fabri-Form Co., 21 pp, ill. Describes numerous sample parts custom-made of thermoplastic and thermosetting plastics, advantages of plastics and fabricating facilities. (34)

Laminated Plastics Parts. The Formica Co.

MANUFACTURERS' LITERATURE

Catalog gives full information on company's facilities for complete machining of Formica custom-made parts. (35)

Polyvinyl Chloride Resins. B. F. Goodrich Chemical Co., 12 pp, ill, No. G-6. Describes applications of new Geon 404 resins, capable of fabrication without plasticizers by conventional methods. Includes properties. (36)

Rubber. B. F. Goodrich Chemical Co. Properties and applications of Hycar, high strength compression and heat resistant rubber suited to heavy duty service. (37)

Rubber Reinforcing Resin. Goodyear Tire & Rubber Co., Chemical Div., No. 601-B. Features and applications of Pliolite S-6B resin giving greater plasticity in rubber processing at low temperatures. (38)

Plastics Tubing. Elmer E. Mills Plastics, Inc., 8 pp, ill. Describes this company's plastic tubing, piping and fittings, including some fabricating data and detailed corrosion information. (39)

Carbon and Graphite Products. National Carbon Co., Inc., 20 pp, ill, No. M-8000-D. Descriptions, specifications and properties of this company's products for chemical, metallurgical, mechanical and electrical applications. (40)

Electric Furnace Refractories. Norton Co., 24 pp, ill. New bulletin tells how to build a laboratory electric furnace indicating which refractories to use. (41)

Alkyd Molding Compound. Plaskon Div., No. A-3. Describes process for use in molding Plaskon Alkyd 420 (granular type) compounds, with data on mold construction, preforming and preheating. (42)

Molded Parts. Resistoflex Corp., 4 pp. ill, No. 4g/3. Properties and uses of this company's custom-molded parts and resinous-lined, reinforced industrial hose. (43)

Molded and Laminated Plastics. The Richardson Co., 24 pp, ill. Basic data on many plastics in use today giving both industrial and consumer uses and the ways they are produced. (44)

Laminated Phenolics. Rogers Corp. "Here's Rogers and Its Fiberloys" describes Rogers Corp. and its laminated phenolics, vulcanized fibres and paperboards. (45)

Sponge Rubber Products. Sponge Rubber Products Co. Shows properties, forms and wide applications of cellular rubber for cushioning, gasketing, sealing, etc. (46)

Molded Ceramics. Star Porcelain Co. Gives technical data on characteristics of molded ceramic production for electrical wiring, electrical heating and special purposes. (47)

Ceramic Laboratory Ware. The Thermal Syndicate, Ltd. Technical description, specifications and prices of Vitreosil ware said to be superior to porcelain in some uses. (48)

Molded Thermoplastics. Tri-State Plastic Molding Co., Inc. Folder describes this company's facilities for producing to order thermoplastics parts by injection molding. (49)

Rubber Parts. Tyer Rubber Co., 4 pp, ill, No. 1c. Describes design and molding service for rubber parts specified by industry. (50)

Plastics. Union Carbide and Carbon Corp., 32 pp, ill, No. 5863-I. Descriptions of various processes and products (plastics, chemicals and metals) this company produces. (51)

Carbon Graphite Parts. U. S. Graphite Co., 68 pp, ill, No. G-49. Properties, chemical resistance, limitations, assembly information, design aids and 60 applications of Graphitar. (52)

Rubber Products. U. S. Rubber Co., 25 pp, ill, No. M-9012. Detailed description of new research and development laboratory, indicating its place in development of rubber products. (53)

Industrial Plastic. Westinghouse Electric Corp., 36 pp, ill, No. B-3184-D. Data book on properties, grades, shapes and sizes, applications and machining of Micarta, a reinforced resin. (54)

Metal Parts • Forms

Die Castings. The Accurate Die Casting Co., 24 pp, ill. Shows company's facilities for producing to order all types of zinc and aluminum die castings. Includes table of alloy properties. (55)

Precision Investment Castings. The Adapti Co., 4 pp, ill, No. C-2M. Close tolerances and stronger metals are among advantages of Adapti Method of precision casting. (56)

Precision Castings. Alloy Precision Castings Co., 8 pp, ill. Describes frozen mercury process for close tolerance precision casting of parts to order. Shows numerous products. (57)

Aluminum Die Castings. Aluminum Co. of America. Book contains detailed technical information for effective design of aluminum die castings. (58)

Aluminum Extruded Shapes. Aluminum Co. of America, No. AD-229. Explains potentialities of extrusion process for aluminum as money-saver in fabrication operations. (59)

Certified Die Castings. American Die Casting Institute, Inc. Discusses plan to protect zinc alloy die castings buyers by subjecting producers' products to regular testing. (60)

Precision Castings. Atlantic Casting and Engineering Co., 721 Bloomfield Ave., Clifton, N. J. "Quality Precision Castings for Industry" explains advantages of Plastermold process, gives specifications on this firm's alloys. Request from Atlantic Casting on company letterhead.

Cold-Formed Steel Shapes. Bethlehem Steel Co. Booklet illustrates various types of cold-formed steel shapes made from strip, sheet or plate giving their features and possible applications. (61)

Cemented Carbide Products. Carboloy Co., 60 pp, ill, No. GT-250. Specifications and applications of this company's cemented carbide tools and blanks, both standard and made to order. (62)

Powdered Metal Parts. Chicago Powdered Metal Products Co., 4 pp, ill. Properties and advantages of Camet custom-molded powdered metal parts. Includes design types. (63)

Heat Resistant Steel Castings. Chicago Steel Foundry Co. Properties of Pyrasteel, chromium-nickel alloy designed for use in high temperature and corrosion resistant castings. (64)

Corrosion Resistant Alloy Castings. The Cooper Alloy Foundry Co., 4 pp. Indicates resistance of corrosion resistant alloys against about 400 corrosive chemicals. (65)

High-Speed Tool Bits. The DoAll Co., 4 pp, ill, No. 51-805. Standard sizes and prices of three types of high-speed tool bits and recommended uses for each. Includes information for ordering, grinding and heat treating. (66)

Fabricated Rings. Dresser Mfg. Div., 8 pp, ill. Generator frames, exhaust manifolds and alternator spiders are some of the illustrated applications of this firm's facilities for ring making. (67)

Corrosion Resistant Castings. The Duraloy Co., 16 pp, ill, No. 3150-G. Describes facilities for manufacture of chromium-iron and chromium-nickel castings. Gives detailed properties of alloys and their uses. (68)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (69)

Investment Castings. Engineered Precision Casting Co., 4 pp, ill. Describes Epco precision investment castings. (70)

Steel Castings. Farrell-Cheek Steel Co., 4 pp, ill, No. 40. Examples of the intricate electric furnace carbon and alloy steel castings produced by this company. (71)

Steel Tubes. Globe Steel Tubes Co., 8 pp, ill, No. 1a/12. Specifications and tolerances of Gloweld-welded seamless tube and pipe of Globe iron and steel. (72)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp, ill, No. 108. Describes Graphalloy grades for bushings and electrical uses. Bearing design data included. (73)

Gray Cast Iron Parts. Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray cast iron. Includes details for designing cast components. (74)

Double-Headed Parts. John Hassall, Inc. Catalog shows numerous double-headed parts, indicating applications and suggesting other applications of double-heading operations. (75)

Precision Investment Castings. Hitchiner Mfg. Co., Inc. Folder shows numerous case histories showing advantages of precision investment casting of parts over other fabricating methods. (76)

Die Castings. The Hoover Co., 12 pp, ill, No. 853. Shows this company's facilities for producing zinc and aluminum die castings. Includes design helps, describes applications. (77)

Iron Castings. Hunt-Spiller Mfg. Corp. Comprehensive data useful in design of metal castings on properties and advantages of gun iron and other metals. (78)

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Aluminum Cable. Kaiser Aluminum & Chemical Corp. Properties of Kaiser Aluminum ACSR and All-Aluminum Cable. Tables of reel sizes given. (79)

Metal Rings. King Fifth Wheel Co. Catalog and capacity charts of this company's facilities for bending and welding metal rings for industrial purposes. (80)

Aluminum Extruded Shapes. Light Metals Corp., 6 pp, ill. Shows facilities for producing to order a variety of indicated aluminum fabrications and extruded shapes. (81)

Die Castings. Madison-Kipp Corp., 32 pp, ill. Describes company's aluminum and zinc die castings. Also shows Kipp Feather-Weight air grinder and Fresh Oil lubricators. (82)

Gray Iron Castings. Meehanite Metal Corp., 8 pp, ill, No. 30. One of a series of bulletins describing the current uses of Meehanite gray iron castings. (83)

Tungsten Carbide Parts. Metal Carbides Corp., No. 50-G. Descriptions and specifications of available Talide Tungsten carbide dies. (84)

Precision Castings. Microcast Div., Austenal Laboratories, Inc., 16 pp. Describes Microcasting process and indicates its advantages in the custom production of small components. (85)

Nonferrous Castings. Monarch Aluminum Mfg. Co., 4 pp, ill. Describes permanent mold castings made by new process to give high, dense finish of great durability. (86)

Screw Machine Parts. Mueller Brass Co., 6 pp, ill. Shows brass, bronze and copper custom-made screw machine parts available, and lists other nonferrous products. (87)

Nonferrous Die Castings. The New Jersey Zinc Co., 28 pp, ill. Applications and principal features of Zamak-3 and Zamak-5 zinc alloy die castings. (88)

Heat Resistant Castings. The Ohio Steel Foundry Co., 8 pp, ill, No. F347. Shows various steel high temperature castings for heat treating purposes. (89)

Perforated Metal Products. Pittsfield Products, Inc., 2 pp, ill. Describes this company's facilities for fabricating wire cloth and perforated metal products. Includes several applications. (90)

Metal Powder Parts. Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy as used by this firm for custom-making parts. (91)

Copper Tubing. Reading Tube Corp., 24 pp, ill. Describes manufacture, properties, specifications and uses of Lektroneal copper tubing. (92)

Mechanical Tubing. Republic Steel Corp., Steel & Tubes Div., 8 pp, ill, No. STMT 100. Advantages, applications, tolerances and properties of this company's Electrunite mechanical tubing. (93)

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Aluminum Stampings. Reynolds Metal Co., Industrial Parts Div., 4 pp, ill, No. 1P600. This company's facilities for producing aluminum stampings and the advantages obtained from their use. (94)

Stainless Steel Cable. John A. Roebling's Sons Co., 4 pp, ill. Case histories showing advantages of this company's Aircord, said to have high strength, great flexibility and small diameter. (95)

Mechanical Tubing. Joseph T. Ryerson & Son, Inc., 4 pp, ill. Specifications and descriptions of round, square and stainless tubings. Includes some applications and indicates other available types. (96)

Spun Metal Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (97)

Cast-Weld Construction. Steel Founders' Society of America, ill. Outlines numerous examples of leading foundries' application of castweld construction to obtain metals savings and production economies. (98)

Small Tubing. Superior Tube Co., 4 pp, ill, No. 32. Available analyses, production limits, commercial tolerances, temper designations and descriptions of this firm's small seamless and Weldrawn tubing. (99)

Steel Forgings. Titusville Forge Div., Struther Wells Corp., 8 pp, ill. Describes facilities for precision forging of parts regardless of size, metal or alloy. Shows numerous parts produced. (100)

Stainless Tubing. Trent Tube Co. *Trentweld Data Bulletin* describes Trentweld stainless steel tubing, machine formed and welded in wide range of sizes. (101)

Steel Castings. Unitcast Corp. Plastic slide indicator gives handy description of properties and compositions of various steels for use in steel castings. (102)

Coatings • Finishes

Chromate Coatings. Allied Research Products, Inc., 4 pp, ill. Characteristics of Iridite chromate coatings; said to give good corrosion protection, paint adherence and wide color choice. (103)

Surface Coating Resins. American Cyanamid Co. Properties, compatability and drying schedules of alkyd, formaldehyde, phenolic and dibasic acid resins for use on surface coatings. (104)

Protective Coatings. Houghton Laboratories, Inc., 3 pp, ill. Applications and uses of "Coradon" and "Coradal" metal conditioning systems for abrasion and chemically resistant coatings. (105)

Phosphate Coating. Parker Rust Proof Co., 7 pp, ill, No. A1521. Describes Bonderite 170 process for coating aluminum for corrosion protection and aiding in drawing. Shows equipment and gives specifications. (106)

Sealing Process for Castings. Western Sealant, Inc., 2 pp, ill. Discusses process for eliminating porosity from metal castings and Fiberglas laminates without visible effects. (107)

Methods and Equipment

Heat Treating • Heating

Model Making Stove. American Lava Corp., 4 pp, ill, No. 146. Properties and methods of heat treating Lava, hydrous aluminum or magnesium silicates useful for model making. (108)

Radiant Glass Panels. Corning Glass Works, 8 pp, ill, No. B-86. Uses and features of Pyrex glass panels coated with electrically conducting coating for radiant heating and drying. (109)

Controlled Atmosphere Furnaces. Dow Furnace Co., 4 pp, ill. Data on batch-type

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controlled atmosphere furnaces for gas cyaniding, carburizing and other operations. (110)

Surface Hardening Compound. Eutectic Welding Alloys Corp., 6 pp, ill. Describes Instant-Hardner for rapid surface hardening of steel tools and parts using a welding torch. (111)

Electric Furnaces. Harper Electric Furnace Corp., 4 pp, ill. Descriptions of various high temperature electric furnaces for special applications and electric tunnel kilns for processing ceramics. (112)

Oil Burners. Hauck Mfg. Co., 8 pp, ill, No. 3-M. Features, applications and accessories of four types of Venturi high pressure industrial oil burners. (113)

Atmosphere Generator. Hevi Duty Electric Co., 2 pp, ill, No. IND-1147-CR. Use, construction and specifications of this company's "Atmo-Gen" units. (114)

Heat Treating Fixtures. Hoskins Mfg. Co. Catalog shows various heat treating fixtures, baskets, etc., made from heat resistant alloys. (115)

Endothermic Generators. Ipsen Industries, Inc., 2 pp, ill, No. G-15. Shows automatic endothermic generators having capacities of 500 and 1000 cu ft per hr. (116)

Immersion Melting Pots. C. M. Kemp Mfg. Co. Technical data on this company's immersion melting pots for melting soft metals with maximum efficiency, good heat control. (117)

High Frequency Heating Units. Lepel High Frequency Laboratories, No. MM-7. Specifications, features and advantages of this company's low cost, high frequency heating units. (118)

Low Frequency Induction Heating. Loftus Engineering Corp., 4 pp, ill. Description, operating characteristics and advantages of this company's 60-cycle induction heating apparatus. (119)

Heat Treating Accessories. Rolock, Inc., 4 pp, ill, No. 949. Describes use of heat and corrosion resistant alloys in baskets, racks, muffles, retorts, trays, etc. (120)

Ammonia Dissociators. Sargeant & Wilbur, Inc., 4 pp, ill, No. A.D. 10. Features, specifications and applications of a variety of this company's ammonia dissociators. (121)

Heat Treating Equipment. Sunbeam Corp., Sunbeam Stewart Industrial Furnace Div., 4 pp, ill, Vol. 10, No. 6. *Metal Minutes* shows various applications of this company's equipment in user's plants. (122)

Heat Treatment of Ammunition. Surface Combustion Corp., 4 pp, ill, No. SC-153. Step-by-step description of heat treatment processes and necessary equipment for beginning-to-end production of ammunition. (123)

Gear-Hardening Machine. Westinghouse Electric Corp., No. B-5259. Describes operation of radio frequency gear-hardening machine for hardening gears and shafts. (124)

Radiant Heaters. Edwin L. Wiegand Co., 29 pp, ill, No. FM-2060. Case histories of Chromalox electric radiant heaters with wide assortment of uses. (125)

Cleaning • Finishing

Metal Plating Facilities. American Nickeloid Co. Brochure shows in detail this company's facilities for plating copper, chromium, nickel and brass on various bases for defense purposes. (126)

Diamond Abrasives. Buehler Ltd., 4 pp. Describes advantages of using Diamet-Hyprez abrasives for polishing metallurgical specimens. (127)

Plating Tanks. The Chemical Corp., 4 pp, ill. Data sheets on chemical resistance of resin bonded Fiberglas plating tanks, their specifications and advantages. (128)

Alkaline Etching Compound. The Diversey Corp., 4 pp, ill, No. 51A. Properties and characteristics of Aluminux, compound for etching aluminum. Includes case histories showing advantages. (129)

Diamond Abrasive. Elgin National Watch Co., 4 pp, ill, No. 5000651. Performance and application advantages of Dymo-C diamond abrasives especially prepared for use on carbide dies. (130)

Industrial Cleaning Equipment. R. C. Mahon Co., 12 pp, ill, No. A-650. Descriptions of high production industrial cleaning and finishing systems designed for equipment of all sizes. (131)

Pickling Process. Neilson Chemical Co., No. 51-3. Complete data on Prep-Pik-l phosphoric acid pickling process said to offer several advantages over sulfuric acid processes. (132)

Paint Stripping. Oakite Products Co. *How to Strip Paint* recommends ways for stripping such finishes as oil-base paints, enamels, alkali-resistant plastics and lacquers. (133)

Die Finishing Process. Pangborn Corp., No. 1400. Data on Hydro-Finish die cleaning process, said to remove oxides, cut hand finishing 60% and maintain 0.0001-in. tolerances. (134)

Metal Cleaner. Philadelphia Quartz Co., ill, No. 33-4 Describes Metso 66 soluble silica heavy duty alkali metal cleaner with brief recommendations for use. (135)

Tumbling Compounds and Processes. Tumb-L-Matic, Inc., 2 pp, No. PC-50. Describes new Tumb-L-Matic wet and dry processes for finishing parts by tumbling. (136)

Welding • Joining

Aluminum Fasteners. Aluminum Co. of America, 8 pp, ill, No. AD-244. Descriptions and specifications of this firm's standard and miscellaneous fasteners and screw machine products. (137)

Stainless Fastenings. Anti-Corrosive Metal Products Co., Inc., 80 pp. Catalog indexes and prices of over 7000 varieties of stainless steel screws, bolts and other fasteners. (138)

Welding Positioners. Cullen-Friestadt Co., ill. Catalog shows line of hand or power operated welding positioners with capacities up to 30,000 lb. (139)

Solder Alloys. Federated Metal Div., 36 pp, ill. Properties of fusible alloys, principles and thermal effects of soldering and applications, descriptions and specifications of this company's solders. (140)

Rivet-Type Fasteners. B. F. Goodrich Co., Rivnut Div. Cardboard "demonstrator" illustrates working principle of Rivnuts, their construction and applications. (141)

Wing Nuts. Gries Reproducer Corp. Data on zinc alloy wing nuts said to be strong, rust-proof, low cost, available in all commercial finishes and thread sizes. (142)

Noncorrosive Fasteners. H. M. Harper Co., 134 pp. Shows 7000 stock fasteners, including bolts, screws, nuts and rivets made of three to ten noncorrosive alloys. (143)

Fasteners. Huck Mfg. Co., 5 pp, ill. Description and specifications of Huck Lockbolts, new high shear strength fasteners incorporating principles of rivets and bolts. (144)

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Helium Arc Welding. The Linde Air Products Co., 28 pp, No. F-6190. Information on welding and hard-facing many commercial metals by the Heliarc process. (145)

Arc Welding Machines. Miller Electric Mfg. Co. Complete line of a.c. arc welding machines said to be adapted to all applications of "Heliarc" process. (146)

Precious Metal Solders. The J. M. Ney Co., 1 p. Melting ranges, colors and identification numbers of this company's gold and platinum solders for electronic tubes. (147)

Weld Screws. The Ohio Nut and Bolt Co. List of stock sizes of weld screws for spot and projection welding made of low carbon steel, brass or stainless steel. (148)

Self-Locking Fasteners. The Palnut Co., 1 p, ill. Describes self-locking machine screw Palnuts, coil tube fasteners, shield can fasteners and acorn Palnuts. (149)

Adjustable Fasteners. South Chester Corp., Southco Div., 4 pp, ill. Describes adjustable door fasteners for machinery doors. Said to be applicable quickly and resist loosening due to vibration. (150)

Carbon Arc Welding. Speer Carbon Co., 8 pp, ill. Advantages of carbon arc welding for fabricating and repairing alloy and nonferrous metals. (151)

Special Fasteners. The Townsend Co., 4 pp, ill, No. TL-63. Descriptions and advantages of Nylok Locknuts and Tufflok Nuts, including specifications and available finishes. (152)

Forming • Casting • Molding • Machining

Maintenance of Cutting Tools. The Carborundum Co., 72 pp, ill, No. 10. Helpful booklet on proper methods for keeping alloy and high-speed steel cutting tools sharp by grinding. (153)

Broaching Machines. Cincinnati Milling Machine Co., 4 pp, ill, No. M-1709-1. Specifications and oil requirements of Hydro-Broach machines. Describes standard equipment and extra accessories. (154)

Plastics Molding Equipment. Improved Paper Machinery Corp., 4 pp, ill. Features and advantages of Impco injection-compression, plunger, transfer and injection molding machines for plastics. (155)

Machining Laminated Plastics. Synthane Corp., 6 pp, ill. Recommended techniques for common machining operations on laminated plastics. Includes properties and design hints. (156)

Punch Presses. Wales-Strippit Corp., 8 pp, ill, No. TC. Describes this company's new twin column presses and their use in blanking, forming, bending, drawing, notching and punching operations. (157)

Metal Forming Facilities. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (158)

Inspection • Testing • Control

Fatigue Testing Machine. The Baldwin-Lima-Hamilton Corp., 2 pp, ill, No. 313. Operating principle, specifications and applications of Sonntag SF-4 fatigue machine. (159)

Laboratory Microscopes. Bausch & Lomb Optical Co., 24 pp, ill, No. D-185. Descriptions and specifications of various microscopes for such uses as metallurgical microanalysis. (160)

Metallograph. Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallographic specimens. (161)

Pyrometers. Claud S. Gordon Co., 4 pp, ill. Uses, applications and specifications of various pyrometers offering a complete line for high and low temperature indications. (162)

Bend Testing Machine. Krouse Testing Machine Co., 4 pp, ill, No. 46-W. Specifications and description of high capacity repeated bending machine. (163)

Universal Testing Machines. National Forge & Ordnance Co., Testing Machine Div., No. 501. Specifications, capacities and operating principle of table model universal testing machines. (164)

Spectrographs. National Spectographic Laboratories, Inc., 4 pp, ill, No. 300. Description, operating principle and control features of spectrograph units for both quantitative and qualitative analysis. (165)

X-Ray Equipment. Picker X-Ray Corp., 8 pp, ill, No. 21250. Describes complete line of X-ray equipment from 50 kv to 24,000 kv. Includes complete accessories and protective equipment. (166)

Tensile Testing Machines. Scott Testers, Inc., 6 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strength of materials such as rubber, paper, wire and thread. (167)

Ultrasonic Inspection Device. Sperry Products, Inc., No. 50-105. Detailed description of Reflectroscope (including specifications) for nondestructive testing of metals to depths of 25 feet. (168)

Pyrometers. Tagliabue Instruments Div., 34 pp, ill, No. 1101 J. Detailed data on Celectray thermal indicating or recording controllers and accessories designed for high sensitivity and accuracy. (169)

Temperature Indicators. Tempil Corp., folder, No. 501. Describes temperature indicating crayon, pellets and coating. Shows useful temperature range and uses. (170)

Thermocouples. Thermo Electric Co., Inc. Catalog describes and gives specifications and advantages of many types of thermocouples, quick coupling connectors, panels and accessories. (171)

General

Chain and Belt Conveyors. Michigan Steel Casting Co., 8 pp, ill, No. 1-B. Shows Misco rivetless chain conveyors and Woodman belt conveyors for high temperatures. (172)

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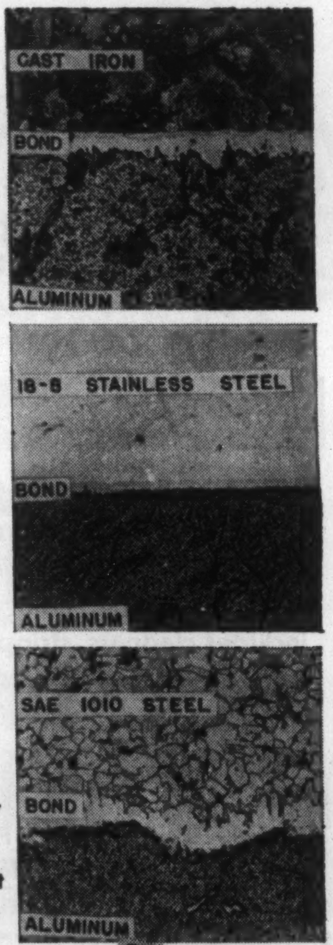

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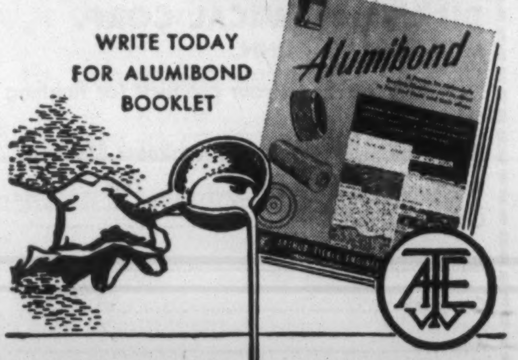

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Meetings and Expositions

American Society of Body Engineers, annual convention. Detroit. Nov. 7-9, 1951.

Meehanite Casting Manufacturers, annual meeting. New York. Nov. 7-9, 1951.

National Foundry Association, annual meeting. Washington, D. C. Nov. 7-9, 1951.

Steel Founders' Society of America, technical and operating conference. Cleveland. Nov. 8-10, 1951.

National Electrical Manufacturers Association, annual meeting. Atlantic City, N. J. Nov. 12-15, 1951.

Magnesium Association, annual meeting, New York. Nov. 15-16, 1951.

National Metal Trades Association, annual convention. Chicago. Nov. 19-20, 1951.

American Society of Mechanical Engineers, annual meeting. Atlantic City, N. J. Nov. 25-30, 1951.

National Chemical Exposition. New York. Nov. 26-Dec. 1, 1951.

Pittsburgh Diffraction Conference. Pittsburgh. Nov. 29-30, 1951.

American Institute of Chemical Engineers, annual meeting. Atlantic City, N. J. Dec. 2-5, 1951.

American Institute of Mining & Metallurgical Engineers, electric furnace steel conference. Pittsburgh. Dec. 6-8, 1951.

Institute of the Aeronautical Sciences, Wright Brothers Lecture. Washington, D. C. Dec. 17, 1951.

American Association for the Advancement of Science, annual meeting. Philadelphia. Dec. 26-31, 1951.

Plant Maintenance Show and Conference. Philadelphia. Jan. 14-17, 1952.

Society of Automotive Engineers, annual meeting. Detroit. Jan. 14-18, 1952.

Society of Plastics Engineers, Inc., national conference. Chicago. Jan. 16-18, 1952.

American Institute of Mining & Metallurgical Engineers, annual meeting. New York. Feb. 18-21, 1952.

American Society for Testing Materials, spring meeting and committee week. Cleveland. Mar. 3-7, 1952.

Society of Automotive Engineers, passenger car, body and materials meeting. Detroit. Mar. 4-6, 1952.

Society of the Plastics Industry, annual national meeting. Philadelphia. Mar. 11-14, 1952.

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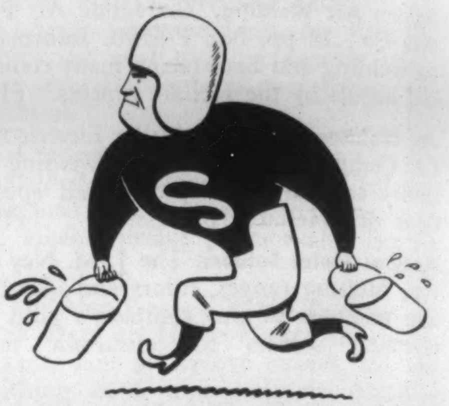

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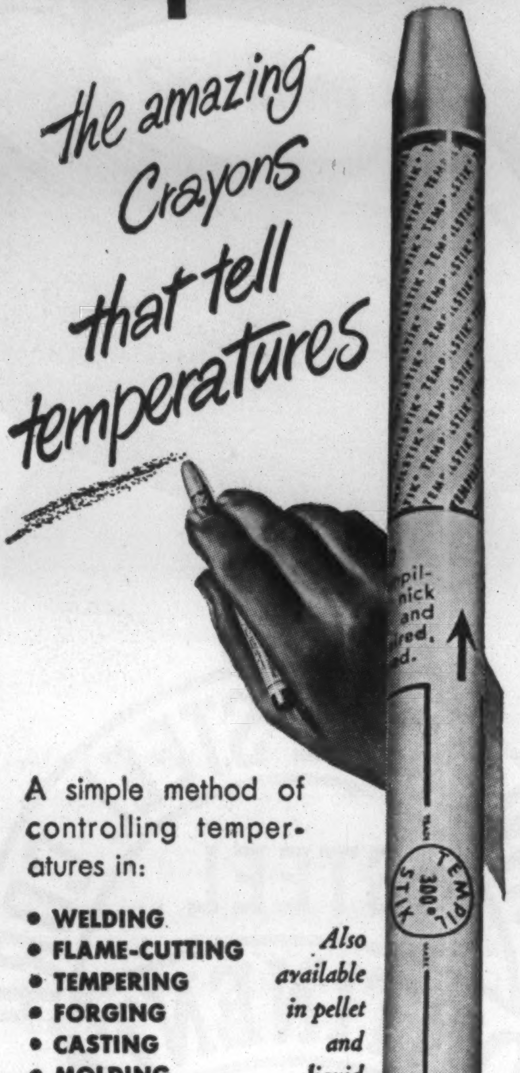
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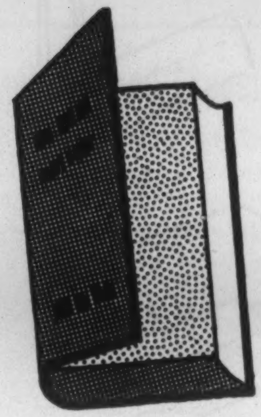

BOOK REVIEWS

THEORY OF PERFECTLY PLASTIC SOLIDS. *By William Prager & Philip G. Hodge, Jr. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1951. Cloth, 6¼ by 9¼ in., 264 pages. Price $5.50.* This book is not an exhaustive treatise on the general theory of plasticity. Rather it is an introduction—the first in English to be written on an intermediate level—to the particular branch of the general theory known as the theory of perfectly plastic solids. The authors cover this branch because it has most nearly taken definitive form, and because numerous results of practical importance are now available or within reach.

WOOD TECHNOLOGY. THIRD EDITION. *By Harry Donald Tiemann. Published by Pitman Publishing Corp., New York 19, N. Y., 1951. Cloth, 6¼ by 9¼ in., 396 pages. Price $6.00.* Due to curtailments during the war, much desirable material was deleted or abridged in the previous edition. This has now been restored or amplified, and considerable new material has been added. This Third Edition now represents the culmination of nearly a lifetime of unrestricted research on lumber production and on the properties, manufacture and uses of wood.

STYRENE. *By A. L. Ward & W. J. Roberts. Published by Interscience Publishers, Inc., New York 1, N. Y., 1951. Cloth 6½ by 9½ in., 132 pages. Price $3.50.* Styrene has become the key substance for the production of synthetic rubber, injection molding powders, and many other products. Information on the investigation, production and application of this compound has been presented in a straight-forward manner, on the basis of the original literature and of the experiences of the authors in the present monograph.

PHASE TRANSFORMATION IN SOLIDS. *By R. Smoluchowski, J. E. Mayer & W. A. Weyl. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1951. Cloth, 5¾ by 8¾ in., 660 pages. Price $9.50.* This book consists of papers presented at a recent symposium held at Cornell University, plus the discussions of these papers. An Editorial Committee, headed by Dr. R. Smoluchowski, prepared the papers and discussions for publication. The papers result in a study which cuts across many fields of science and unifies the knowledge gained in each of the fields in a critical survey of the basic theories and experimental facts of the solid state.

ELECTRO-PLATING — A SURVEY OF MODERN PRACTICE. SIXTH EDITION. *By Samuel Field & A. Dudley Weill. Published by Pitman Publishing Corp., New York 19, N. Y., 1951. Cloth, 5¼ by 7½ in., 546 pages. Price $6.00.* This book explains and illustrates the latest methods used in electro-plating, the principles underlying modern processes, and the plant and apparatus employed in every branch of the work. Comprehensive, well illustrated and thoroughly practical, it is an essential guide for the student, the practical plater, and all concerned with the technical side of the industry.

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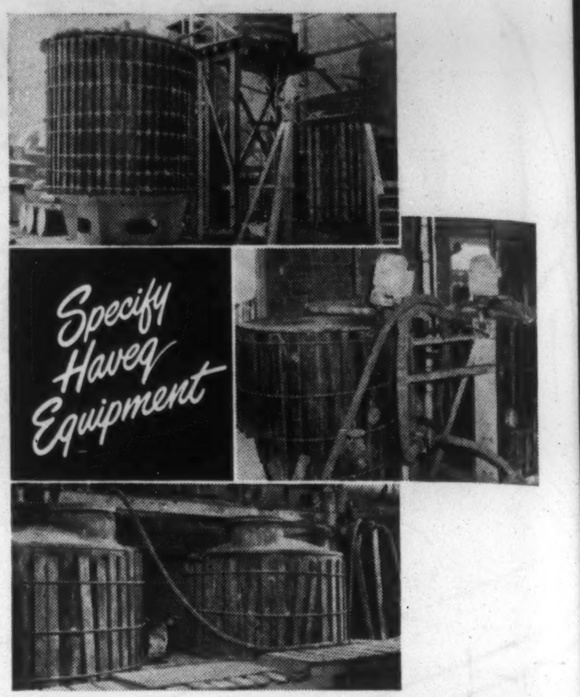

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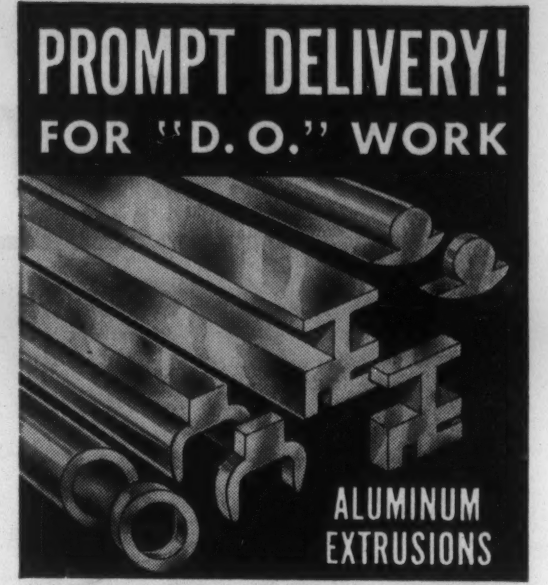

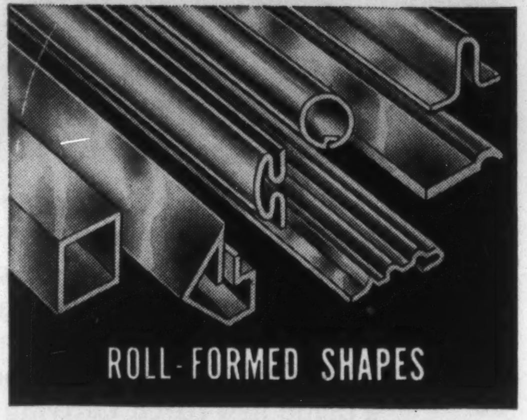

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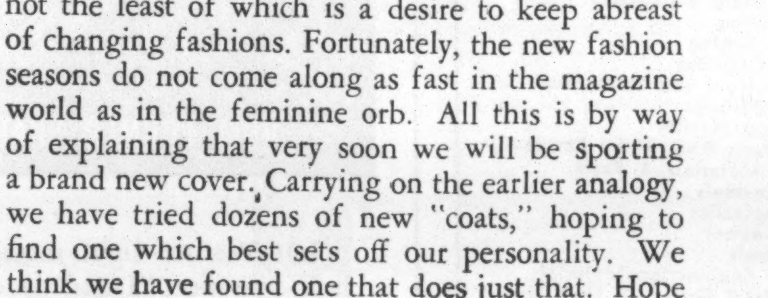
The Editor's Page

Time for a New Overcoat

Magazines have many traits of the feminine sex, not the least of which is a desire to keep abreast of changing fashions. Fortunately, the new fashion seasons do not come along as fast in the magazine world as in the feminine orb. All this is by way of explaining that very soon we will be sporting a brand new cover. Carrying on the earlier analogy, we have tried dozens of new "coats," hoping to find one which best sets off our personality. We think we have found one that does just that. Hope you like it, too!



Some Advice

At the NPA meeting referred to, one speaker advised that all copper users should search for places where aluminum could be used as an alternate. His point was that aluminum supplies will be ample long before we have sufficient copper.

Mindful of the aluminum-copper situation, one of the oldest copper companies recently announced that it was going into the aluminum business in order that it might better serve its customers.

Longies vs Shorts

No, we're not talking about red flannels. For years there has been a running feud in both advertising and editorial circles between the advocates of long articles and copy and those who are strong in the belief that what you say is the important thing, not the length. We can present good exhibits to bolster either side of the editorial argument. However, one of the best demonstrations of how to use long advertising appeared in our September issue. There, U. S. Rubber really gives a complete story on polyester resins. In one page there are more than 1,000 words used to carry the message. In this instance the old Chinese adage is reversed to the extent that no picture could convey the desired message one-thousandth as well as these well chosen words.

Needed: More Adjectives

Titanium and zirconium have been coming in for their share of attention in the newspapers and general publications recently. In describing these metals, various writers have drawn upon their store of adjectives to serve as a cover for their lack of knowledge. For example, titanium has been referred to frequently as the "Cinderella" metal. Now zirconium has become the "magic" metal. The latter reference was made in revealing that zirconium is used in a new ointment for poison ivy. More surprising than the adjective is the statement that zirconium is a secret metal.

An Observation on NPA

Recently a group of editors whose magazines are strongly interested in metals were called to Washington for a session with the heads of the various metals divisions of NPA. It was a question and answer get-together which proved worthwhile. Among many other facts and impressions gained at the meeting, one stands out. That is that NPA boys seem to think that many of the materials shortages today are due in part to the pricing policies of the OPS. World prices for most metals are higher than our ceiling, so the metals are sold elsewhere first. Too, scrap ceilings have held down the movement of scrap of many types.

Another impression gained is that most of the men heading the various NPA divisions are honest and capable and are trying to do a good job. However, they are often hamstrung by jealousies over authority on the part of other bureaus, as well as by actions these bureaus take.

T. C. Du Mond
Editor